# create-and-update-did-btc1

September 1, 2025

## Creating and Updating a did:btc1 Identifier

### A `did:btc1` Demo

In this demo you will learn:

1. How to create a did:btc1 Decentralized Identifier (DID) from an external intermediate DID document.
2. How to construct a BTC1 Update that mutates the initial DID document.
3. How to announce and anchor this BTC1 Update to the Bitcoin blockchain using a BTC1 Beacon.
4. How to resolve the did:btc1 identifier using the Universal Resolver.

## High level outline

1. **Key Management**: Generate a BIP32 seed phrase, HD Key and derive the required cryptographic key material needed for the signing and Beacon operations in this workshop.
2. **did:btc1 identifier construction**: Construct a did:btc1 identifier and its associated capabilities in a valid DID document.
3. **Resolving a did:btc1 identifier using Sidecar Data**: Construct the Sidecar Data required to resolve an external did:btc1 identifier and execute a resolution request through the universal resolver
4. **Construct a BTC1 Update**: Construct and invoke a BTC1 Update to add a new Verification Method to a did:btc1 DID document.
5. **Announce a BTC1 Update**: Announce the BTC1 Update by broadcasting a Beacon Signal from the SingletonBeacon defined within the DID document.
6. **Resolve updated did:btc1 identifier**: Construct the Sidecar Data necessary to resolve the updated did:btc1 identifier using the universal resolver.

## 0. Config

[1]:
```
# What Bitcoin network do you want the identifier to be rooted to?
did_network = "mutinynet"
network_type = "signet"
```

## 1. Key Management

[2]:
```
from buidl.hd import secure_mnemonic, HDPrivateKey
```

### 1.1. Generate HD root from secure mnemonic

[3]:
```
mnemonic = 'bicycle bid language artwork minimum case cream ill tribe dragon␣
  ↪stage trophy convince kiwi drift salmon destroy transfer retire knock rifle␣
  ↪humble bench drift'

########
# Uncomment if you want to use your own mnemonic
########
# mnemonic = secure_mnemonic()
# print(mnemonic)

hd_root = HDPrivateKey.from_mnemonic(mnemonic)
```

### 1.2. Derive keypair for a verificationMethod

A verificationMethod is for defining cryptographic material that can participate in verifiable interactions.

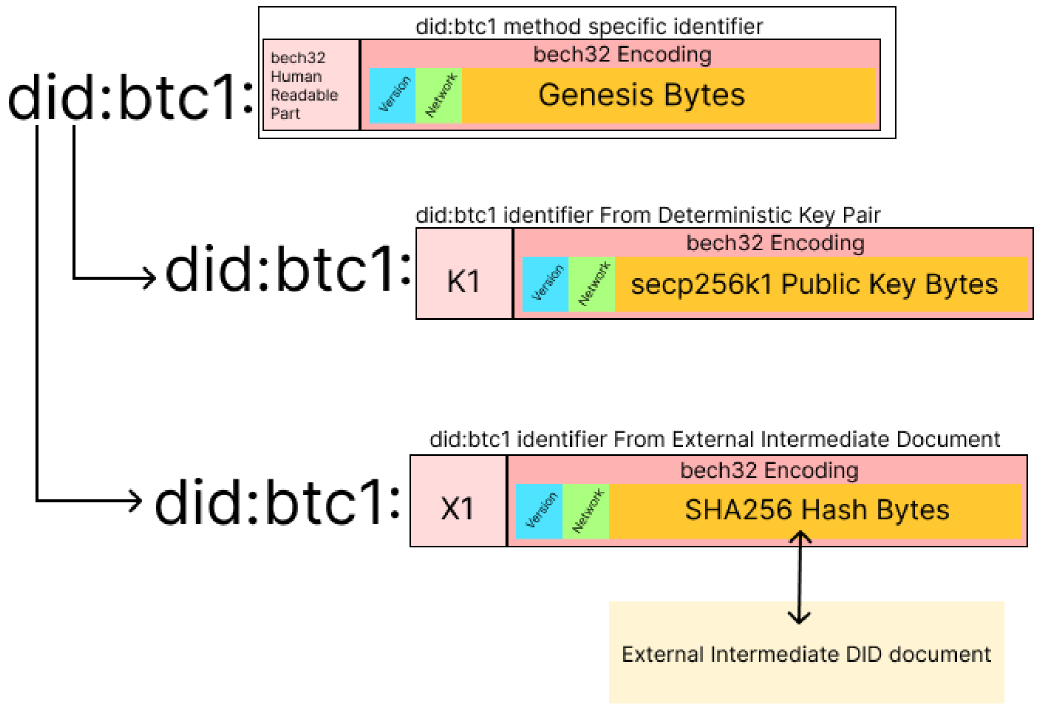
[4]:
```
key_index = 0

# This could be anything. Just picking a derivation path non standard in the␣
  ↪btc community.
did_purpose = "111"

vm_sk = hd_root.get_private_key(did_purpose, address_num=key_index)
vm_pk = vm_sk.point
```

## 1.3. Derive keypair for a SingletonBeacon Service

This is the BTC1 Beacon that is used to announce updates to the DID document. We will not be using this Beacon in this workshop, but all `did:btc1` identifiers should contain at least one SingletonBeacon.

[5]:
```
# Need to increment so we get a different key each time
key_index+=1

singleton_sk = hd_root.get_private_key(did_purpose, address_num=key_index)
singleton_pk = singleton_sk.point
```

## 2. did:btc1 Identifier Construction


did:btc1:
did:btc1 method specific identifier
bech32 Human Readable Part
bech32 Encoding
Version
Network
Genesis Bytes
did:btc1 identifier From Deterministic Key Pair
did:btc1:
K1
bech32 Encoding
secp256k1 Public Key Bytes
did:btc1 identifier From External Intermediate Document
did:btc1:
X1
bech32 Encoding
SHA256 Hash Bytes
External Intermediate DID document

### 2.1. Instantiate a Builder for an IntermediateBtc1DIDDocument

This builder constructs the instantiating intermediate document that is used to generate the `did:btc1` identifier, binding the initial state of the DID document with the identifier itself.

[6]:
```
from libbtc1.diddoc.builder import IntermediateBtc1DIDDocumentBuilder
from libbtc1.did import PLACEHOLDER_DID

# A placeholder that is put everywhere the actual did:btc1 identifier should be␣
↪once it is constructed
print(PLACEHOLDER_DID)

builder = IntermediateBtc1DIDDocumentBuilder()
```

```
did:btc1:xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
```

### 2.2. Add a VerificationMethod to the DID document

[7]:
```
from libbtc1.multikey import get_public_key_multibase
from pydid.verification_method import Multikey

# Convert to multibase representation of public key bytes
pk_multibase = get_public_key_multibase(vm_pk.sec())
```

```
vm = builder.verification_method.add(Multikey, controller=PLACEHOLDER_DID,␣
↪public_key_multibase = pk_multibase)
```

[8]:
```
vm
```

[8]:
```
Multikey(id='did:btc1:xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
xx#key-0', type='Multikey', controller='did:btc1:xxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
xxxxxxxxxxxxxxxxxxxxxxxxxxxxx', public_key_hex=None, public_key_base58=None,
public_key_pem=None,
public_key_multibase='zQ3shSnvxNK94Kpux1sp8RCWfn4dTFcAr1fZLf7E3Dy19mEBi',
blockchain_account_id=None, ethereum_address=None, public_key_jwk=None)
```

## 2.3. Add assertionMethod Verification Relationship to DID document

When you make a VerifiableStatement you will use the VerificationMethod from 2.2. to sign a VerifiableCredential with the proofPurpose of `assertionMethod`. In this step, you are letting anyone who resolves your DID document know you intend to use the Verification Method for this purpose.

[9]:
```
builder.assertion_method.reference(vm.id)
```

## 2.4. Add capabilityInvocation Verification Relationship to DID document

This is the same as step 2.3., but for the `capabilityInvocation` relationship. All `did:btc1` documents should have at least one Verification Method able to execute capability invocations, this is how they authorize updates to the DID document. In this set of notebooks we will not be updating the DID document.

*Note: Technically, it is best practice to have separate Verification Methods for these different verification relationships. For simplicity I have not done this.*

[10]:
```
builder.capability_invocation.reference(vm.id)
```

## 2.5. Add SingletonBeacon service to DID document

The SingletonBeacon provides a mechanism for the DID controller to announce and anchor to the Bitcoin blockchain through a Beacon Signal that they have made an update to the DID document. A DID controller can have multiple Beacons for this purpose in their DID document, including Beacons that aggregate multiple updates from distinct `did:btc1` identifiers. In this series of notebooks, we will not be updating the DID document.

[11]:
```
# Generate Beacon script and address for SingletonBeacon
beacon_script = singleton_pk.p2wpkh_script()
address = beacon_script.address(network=network_type)

# Spends from this address should be considered Beacon Signals
# These signals should be processed according to the type of the Beacon as␣
↪defined in the DID document
print("SingletonBeacon address: ", address)
```

```
beacon_service = builder.service.add_singleton_beacon(beacon_address=address)
```

```
SingletonBeacon address:  tb1qtmshuqzeyr7cdh5t2nl6kf3s73fdynpj5apgtx
```

## 2.6. Construct did:btc1 DID document

[12]:
```python
from libbtc1.did_manager import DIDManager
import json

intermediate_doc = builder.build()

print("\nIntermediate DID Document: ")
print(json.dumps(intermediate_doc.serialize(), indent=2))

did_manager = DIDManager(did_network=did_network, btc_network=network_type)

btc1_identifier, did_doc = did_manager.create_external(intermediate_doc,␣
 ↪did_network)

print("\n\n")
print(btc1_identifier)
print("\nDID Document: ")
print(json.dumps(did_doc.serialize(), indent=2))

v1_did_document = did_doc.model_copy(deep=True)
```

```
Intermediate DID Document:
{
  "@context": [
    "https://www.w3.org/TR/did-1.1",
    "https://did-btc1/TBD/context"
  ],
  "id": "did:btc1:xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx",
  "verificationMethod": [
    {
      "id":
"did:btc1:xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx#key-0",
      "type": "Multikey",
      "controller":
"did:btc1:xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx",
      "publicKeyMultibase": "zQ3shSnvxNK94Kpux1sp8RCWfn4dTFcAr1fZLf7E3Dy19mEBi"
    }
  ],
  "assertionMethod": [
"did:btc1:xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx#key-0"
  ],
  "capabilityInvocation": [
"did:btc1:xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx#key-0"
  ],
  "service": [
    {
      "id": "did:btc1:xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
xx#service-0",
      "type": "SingletonBeacon",
      "serviceEndpoint": "bitcoin:tb1qtmshuqzeyr7cdh5t2nl6kf3s73fdynpj5apgtx"
    }
  ]
}
```

```
did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl

DID Document:
{
  "@context": [
    "https://www.w3.org/TR/did-1.1",
    "https://did-btc1/TBD/context"
  ],
  "id":
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl",
  "verificationMethod": [
    {
      "id":
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl#key-0",
      "type": "Multikey",
      "controller":
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl",
      "publicKeyMultibase": "zQ3shSnvxNK94Kpux1sp8RCWfn4dTFcAr1fZLf7E3Dy19mEBi"
    }
  ],
  "assertionMethod": [
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl#key-0"
  ],
  "capabilityInvocation": [
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl#key-0"
  ],
  "service": [
    {
      "id": "did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qx
fgl#service-0",
      "type": "SingletonBeacon",
      "serviceEndpoint": "bitcoin:tb1qtmshuqzeyr7cdh5t2nl6kf3s73fdynpj5apgtx"
    }
  ]
}
```

```
[ ]:
```

## 3. Resolving a did:btc1 identifier using Sidecar Data

In order to resolve the did:btc1 identifier just produced, a DID resolver must be able to validate an initial DID document against the method specific identifier itself. To be able to do so, a DID resolver must be provided with more than just the did:btc1 identifier as part of a resolution request. For external did:btc1 identifiers, DID resolvers must be provided with the initial DID document which they can then validate against the identifier.

Later in this demo we will see how Sidecar Data can also be used to provided information necessary to validate specific BTC1 Updates announced in Beacon Signals.

### 3.1 Construct Sidecar Data

Note: The data model for Sidecar Data is in flux and likely to change (see `https://github.com/dcdpr/did-btc1/issues/178`).

```
[13]: sidecar_data = {}
sidecar_data["initialDocument"] = did_doc.serialize()

print(json.dumps(sidecar_data, indent=2))
```

```
{
  "initialDocument": {
    "@context": [
      "https://www.w3.org/TR/did-1.1",
      "https://did-btc1/TBD/context"
    ],
    "id":
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl",
    "verificationMethod": [
      {
        "id":
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl#key-0",
        "type": "Multikey",
        "controller":
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl",
        "publicKeyMultibase":
"zQ3shSnvxNK94Kpux1sp8RCWfn4dTFcAr1fZLf7E3Dy19mEBi"
      }
    ],
    "assertionMethod": [
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl#key-0"
    ],
    "capabilityInvocation": [
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl#key-0"
    ],
    "service": [
      {
        "id": "did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2
qxfgl#service-0",
        "type": "SingletonBeacon",
        "serviceEndpoint": "bitcoin:tb1qtmshuqzeyr7cdh5t2nl6kf3s73fdynpj5apgtx"
      }
    ]
  }
}
```

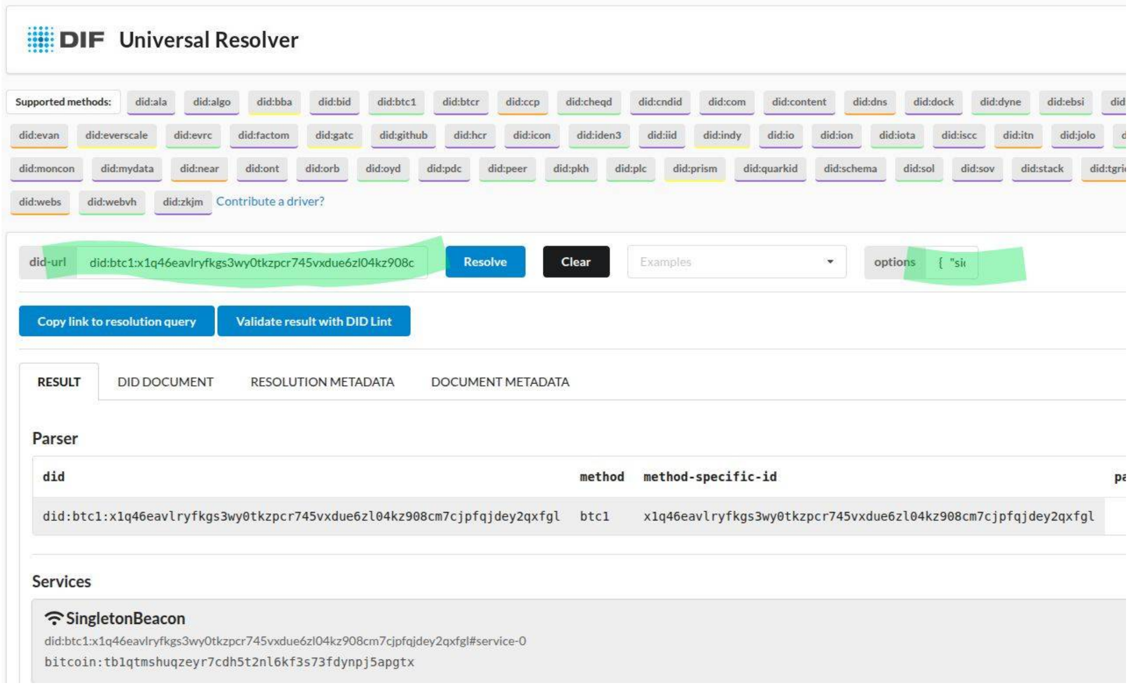
### 3.2 Construct a Resolution Options object

DID Resolution Options is an extensible object passed as part of a resolution request `resolve(did, resolutionOptions)`. It is our intention to define `sidecarData` (or similar) as a extension property within the resolution options that can be used to convey Sidecar Data to DID resolvers as part of a Resolution Request.

[14]:
```
resolution_options = {}
resolution_options["sidecarData"] = sidecar_data
```

### 3.3 Execute a Resolution Request using the Universal Resolver

1. Visit the Universal Resolver.
2. Paste in the did:btc1 identifier and the resolution_options object (printed below) into the respective fields.
3. Execute a Resolution Request (click the resolve button).


DIF Universal Resolver
Supported methods:
did:ala did:algo did:bba did:bid did:btc1 did:btcr did:ccp did:cheqd did:cndid did:com did:content did:dns did:dock did:dyne did:ebsi
did:evan did:everscale did:evrc did:factom did:gatc did:github did:hcr did:icon did:iden3 did:iid did:indy did:io did:ion did:iota did:iscc did:itn did:jolo
did:moncon did:mydata did:near did:ont did:orb did:oyd did:pdc did:peer did:pkh did:plc did:prism did:quarkid did:schema did:sol did:sov did:stack
did:webs did:webvh did:zkjm Contribute a driver?
Resolve
Clear
Examples
Copy link to resolution query
Validate result with DID Lint
RESULT
DID DOCUMENT
RESOLUTION METADATA
DOCUMENT METADATA

did-url did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908c

options { "si

Parser

| did | method | method-specific-id |
|---|---|---|
| did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl | btc1 | x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl |

Services

SingletonBeacon
did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl#service-0
bitcoin:tb1qtmshuqzeyr7cdh5t2nl6kf3s73fdynpj5apgtx

```
[15]: # The did:btc1 identifier to resolve
      print(btc1_identifier)
```

```
did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl
```

```
[16]: # The resolution options for the resolution request
      print(json.dumps(resolution_options, indent=2))
```

```
{
  "sidecarData": {
    "initialDocument": {
      "@context": [
        "https://www.w3.org/TR/did-1.1",
        "https://did-btc1/TBD/context"
      ],
      "id":
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl",
      "verificationMethod": [
        {
          "id":
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl#key-0",
          "type": "Multikey",
          "controller":
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl",
          "publicKeyMultibase":
"zQ3shSnvxNK94Kpux1sp8RCWfn4dTFcAr1fZLf7E3Dy19mEBi"
        }
      ],
      "assertionMethod": [
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl#key-0"
      ],
      "capabilityInvocation": [
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl#key-0"
      ],
      "service": [
        {
          "id": "did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjde
y2qxfgl#service-0",
          "type": "SingletonBeacon",
          "serviceEndpoint":
"bitcoin:tb1qtmshuqzeyr7cdh5t2nl6kf3s73fdynpj5apgtx"
        }
      ]
    }
  }
}
```

## 4. Construct and invoke a BTC1 Update to add a new Verification Method

A BTC1 Update contains:

- `patch`: A JSON Patch object that defines a set of transformations.
- `targetVersionId`: The version of the DID document after the BTC1 Update has been applied.
- `sourceHash`: The encoded SHA256 hash of the canonicalized source DID document.
- `targetHash`: The encoded SHA256 hash of the canonicalized target DID document (the DID document after the BTC1 Update has been applied).
- `proof`: A Data Integrity proof for the purpose of securing and invoking the BTC1 Update. This invocation must be made by a verificationMethod .authorized to produce `capabilityInvocation` in the source DID document.

### 4.1 Generate new Key Pair

[17]:
```
key_index += 1

vm2_sk = hd_root.get_private_key(did_purpose, address_num=key_index)
vm2_pk = vm_sk.point
```

### 4.2 Build a Verification Method

[18]:
```
from pydid.doc.builder import VerificationMethodBuilder

document_to_update = v1_did_document.model_copy(deep=True)

```

```
pk2_multibase = get_public_key_multibase(vm2_pk.sec())

vm_builder = VerificationMethodBuilder(btc1_identifier,␣
↪methods=document_to_update.verification_method)

vm2 = vm_builder.add(Multikey, public_key_multibase=pk2_multibase)


vm2_json = vm2.serialize()
print(json.dumps(vm2_json, indent=2))
```

```
{
  "id":
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl#key-1",
  "type": "Multikey",
  "controller":
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl",
  "publicKeyMultibase": "zQ3shSnvxNK94Kpux1sp8RCWfn4dTFcAr1fZLf7E3Dy19mEBi"
}
```

### 4.3 Construct BTC1 Update Patch

Following JSON Patch, this patch object adds the rerification method to the set of verification methods and authorizes this verification method for the authentication verification relationship.

[19]:
```
vm_path = f"/verificationMethod/{len(v1_did_document.verification_method)}"
authentication_path = "/authentication"
patch = [
    {'op': 'add', 'path': vm_path, 'value': vm2_json},
    {'op': 'add', 'path': authentication_path, 'value' : [vm2_json['id']]}
]
```

[20]:
```
print(json.dumps(patch, indent=2))
```

```
[
  {
    "op": "add",
    "path": "/verificationMethod/1",
    "value": {
      "id":
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl#key-1",
      "type": "Multikey",
      "controller":
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl",
      "publicKeyMultibase": "zQ3shSnvxNK94Kpux1sp8RCWfn4dTFcAr1fZLf7E3Dy19mEBi"
    }
  },
  {
    "op": "add",
    "path": "/authentication",
    "value": [
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl#key-1"
    ]
  }
]
```

## 4.4 Apply BTC1 Update Patch

Here we apply the patch we just created, and manually check that the patch is doing what we intended.

[21]:
```
import jsonpatch

v1_document = v1_did_document.model_copy(deep=True).serialize()
json_patch = jsonpatch.JsonPatch(patch)

v2_document = json_patch.apply(v1_document)

print("Version 1 DID document:\n")
print(json.dumps(v1_document, indent=2))
print("\n\n")
print("Version 2 DID document:\n")
print(json.dumps(v2_document, indent=2))
```

```
Version 1 DID document:

{
  "@context": [
    "https://www.w3.org/TR/did-1.1",
    "https://did-btc1/TBD/context"
  ],
  "id":
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl",
  "verificationMethod": [
    {
      "id":
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl#key-0",
      "type": "Multikey",
      "controller":
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl",
      "publicKeyMultibase": "zQ3shSnvxNK94Kpux1sp8RCWfn4dTFcAr1fZLf7E3Dy19mEBi"
    }
  ],
  "assertionMethod": [
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl#key-0"
  ],
  "capabilityInvocation": [
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl#key-0"
  ],
  "service": [
    {
      "id": "did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qx
fgl#service-0",
      "type": "SingletonBeacon",
      "serviceEndpoint": "bitcoin:tb1qtmshuqzeyr7cdh5t2nl6kf3s73fdynpj5apgtx"
    }
  ]
}
```

Version 2 DID document:

```
{
  "@context": [
    "https://www.w3.org/TR/did-1.1",
    "https://did-btc1/TBD/context"
  ],
  "id":
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl",
  "verificationMethod": [
    {
      "id":
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl#key-0",
      "type": "Multikey",
      "controller":
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl",
      "publicKeyMultibase": "zQ3shSnvxNK94Kpux1sp8RCWfn4dTFcAr1fZLf7E3Dy19mEBi"
    },
    {
      "id":
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl#key-1",
      "type": "Multikey",
      "controller":
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl",
      "publicKeyMultibase": "zQ3shSnvxNK94Kpux1sp8RCWfn4dTFcAr1fZLf7E3Dy19mEBi"
    }
  ],
  "assertionMethod": [
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl#key-0"
  ],
  "capabilityInvocation": [
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl#key-0"
  ],
  "service": [
    {
      "id": "did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qx
fgl#service-0",
      "type": "SingletonBeacon",
      "serviceEndpoint": "bitcoin:tb1qtmshuqzeyr7cdh5t2nl6kf3s73fdynpj5apgtx"
    }
  ],
  "authentication": [
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl#key-1"
  ]
}
```

### 4.5 Calculate source and target hashes and set the target version ID

We are likely going to switch from JSON Canonicalization (JCS) to RDF Canonicalization.

[22]:
```
import jcs
from buidl.helper import sha256, bytes_to_str
import base58

source_hash = sha256(jcs.canonicalize(v1_document))
# Note: we will be moving to base64 encoding
encoded_source_hash = bytes_to_str(base58.b58encode(source_hash))

target_hash = sha256(jcs.canonicalize(v2_document))
# Note: we will be moving to base64 encoding
encoded_target_hash = bytes_to_str(base58.b58encode(target_hash))

# Version increments starting from 1 (the version of the initial DID document)
target_version_id = 2
```

### 4.6 Construct Unsecured BTC1 Update

This is the BTC1 Update object before a proof invoking the update has been attached.

[23]:
```
unsecured_btc1_update = {}

# Note: we will be adding out BTC1 context here which will define the terms in␣
 ↪the BTC1 Update
unsecured_btc1_update["@context"] = [
    'https://w3id.org/security/v2',
    'https://w3id.org/zcap/v1',
    'https://w3id.org/json-ld-patch/v1'
]

unsecured_btc1_update["patch"] = patch

unsecured_btc1_update["sourceHash"] = encoded_source_hash
```

```python
unsecured_btc1_update["targetHash"] = encoded_target_hash
unsecured_btc1_update["targetVersionId"] = target_version_id

print(json.dumps(unsecured_btc1_update, indent=2))
```

```
{
  "@context": [
    "https://w3id.org/security/v2",
    "https://w3id.org/zcap/v1",
    "https://w3id.org/json-ld-patch/v1"
  ],
  "patch": [
    {
      "op": "add",
      "path": "/verificationMethod/1",
      "value": {
        "id":
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl#key-1",
        "type": "Multikey",
        "controller":
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl",
        "publicKeyMultibase":
"zQ3shSnvxNK94Kpux1sp8RCWfn4dTFcAr1fZLf7E3Dy19mEBi"
      }
    },
    {
      "op": "add",
      "path": "/authentication",
      "value": [
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl#key-1"
      ]
    }
  ],
  "sourceHash": "GQi1k4ATu3k3UBhES7b8m45U7edzqB3fSRCX9hp83kmb",
  "targetHash": "YBxGFw1r4PwjoNBGEfgvvEntGKGXpYDz2XFPNgTweba",
  "targetVersionId": 2
}
```

## 4.7 Secure and invoke the Unsecured BTC1 Update

Add a Data Integrity proof to the unsecured BTC1 Update document for the purposing of invoking the capability to update the DID document.

### 4.7.1 Instantiate a signing key associated with the verification method that will invoke the capability

This is a verification method that must be authorized by the source DID document for the capabilityInvocation verification relationship.

```
[24]: # Here we can see the source (v1) DID document has one verification method
      # And that verification method IS authorized for the capabilityInvocation␣
       ↪relationship
      print(json.dumps(v1_document, indent=2))
```

```
{
  "@context": [
    "https://www.w3.org/TR/did-1.1",
    "https://did-btc1/TBD/context"
  ],
  "id":
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl",
  "verificationMethod": [
    {
      "id":
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl#key-0",
      "type": "Multikey",
      "controller":
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl",
      "publicKeyMultibase": "zQ3shSnvxNK94Kpux1sp8RCWfn4dTFcAr1fZLf7E3Dy19mEBi"
    }
  ],
  "assertionMethod": [
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl#key-0"
  ],
  "capabilityInvocation": [
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl#key-0"
  ],
  "service": [
    {
      "id": "did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qx
fgl#service-0",
      "type": "SingletonBeacon",
      "serviceEndpoint": "bitcoin:tb1qtmshuqzeyr7cdh5t2nl6kf3s73fdynpj5apgtx"
    }
  ]
}
```

```
[25]: verification_method = v1_document["verificationMethod"][0]

      from di_bip340.multikey import SchnorrSecp256k1Multikey

      multikey = SchnorrSecp256k1Multikey(id=verification_method["id"],␣
       ↪controller=btc1_identifier, private_key=vm_sk)
```

### 4.7.2 Instantiate the BIP340 Cryptosuite

See https://dcdpr.github.io/data-integrity-schnorr-secp256k1/

```
[26]: from di_bip340.cryptosuite import Bip340JcsCryptoSuite
      from di_bip340.data_integrity_proof import DataIntegrityProof

      cryptosuite = Bip340JcsCryptoSuite(multikey)
      di_proof = DataIntegrityProof(cryptosuite)
```

### 4.7.3 Deterministically generate the root capability identifier for the capability to update the did:btc1 identifier

The did:btc1 DID method specification defines an algorithm to go from a did:btc1 identifier to the root capability to update the DID document of this identifier.

```
[27]: import urllib
      root_capability_id = f"urn:zcap:root:{urllib.parse.quote(btc1_identifier)}"

      print(root_capability_id)
```

```
urn:zcap:root:did%3Abtc1%3Ax1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjd
ey2qxfgl
```

### 4.7.4 Define the Data Integrity proof configuration options

These proof configuration options identifier:

- The cryptosuite that will be used to generate the proof.
- The identifier of the verificationMethod that is producing the proof (this ID can be dereferenced to the JSON object for that VM).
- The proof purpose (capabilityInvocation).
- The capability being invoked. (this ID can be derefenced to the root capability object).

```
[28]: options = {
          "type": "DataIntegrityProof",
          "cryptosuite": "bip340-jcs-2025",
          "verificationMethod": multikey.full_id(),
          "proofPurpose": "capabilityInvocation",
          "capability": root_capability_id,
          "capabilityAction": "Write"
      }

      print(json.dumps(options, indent=2))
```

```
{
  "type": "DataIntegrityProof",
  "cryptosuite": "bip340-jcs-2025",
  "verificationMethod":
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl#key-0",
  "proofPurpose": "capabilityInvocation",
  "capability": "urn:zcap:root:did%3Abtc1%3Ax1q46eavlryfkgs3wy0tkzpcr745vxdue6zl
04kz908cm7cjpfqjdey2qxfgl",
  "capabilityAction": "Write"
}
```

### 4.7.4 Add a capability invocation Data Integrity proof to the BTC1 Update object

In the output, notice the new proof object that has been attached to the document.

```
[29]: btc1_update = di_proof.add_proof(unsecured_btc1_update, options)

      print(json.dumps(btc1_update, indent=2))
```

```
{
  "@context": [
    "https://w3id.org/security/v2",
    "https://w3id.org/zcap/v1",
    "https://w3id.org/json-ld-patch/v1"
  ],
  "patch": [
    {
      "op": "add",
      "path": "/verificationMethod/1",
      "value": {
        "id":
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl#key-1",
        "type": "Multikey",
        "controller":
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl",
        "publicKeyMultibase":
"zQ3shSnvxNK94Kpux1sp8RCWfn4dTFcAr1fZLf7E3Dy19mEBi"
      }
    },
    {
      "op": "add",
      "path": "/authentication",
      "value": [
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl#key-1"
      ]
    }
  ],
  "sourceHash": "GQi1k4ATu3k3UBhES7b8m45U7edzqB3fSRCX9hp83kmb",
  "targetHash": "YBxGFw1r4PwjoNBGEfgvvEntGKGXpYDz2XFPNgTweba",
  "targetVersionId": 2,
  "proof": {
    "type": "DataIntegrityProof",
    "cryptosuite": "bip340-jcs-2025",
    "verificationMethod":
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl#key-0",
    "proofPurpose": "capabilityInvocation",
    "capability": "urn:zcap:root:did%3Abtc1%3Ax1q46eavlryfkgs3wy0tkzpcr745vxdue6
zl04kz908cm7cjpfqjdey2qxfgl",
    "capabilityAction": "Write",
    "@context": [
      "https://w3id.org/security/v2",
      "https://w3id.org/zcap/v1",
      "https://w3id.org/json-ld-patch/v1"
    ],
    "proofValue": "z5kdS3pqKroucErsUgMoTsquvV5QVHNJZtTu4c4GcjR2T26tNihacbvYxbCfy
bjBakMMgy3uSFCZrqvBjuLT5kWSE"
  }
}
```

## 5. Announce the BTC1 Update through a Beacon Signal broadcast from the SingletonBeacon in the DID document

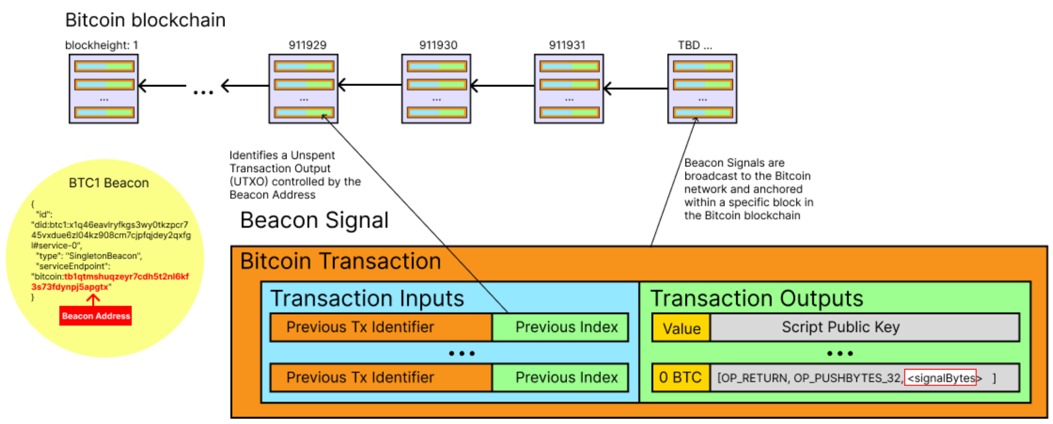
BTC1 Beacons, identified by a Bitcoin address and included within a DID document, are the mechanism by which BTC1 Updates are announced and anchored within the Bitcoin blockchain. This enables DID resolvers to discover the existence of BTC1 Updates relating to specific did:btc1 identifiers they are resolving.

BTC1 Beacons broadcast Beacon Signals, Bitcoin transactions that spend at least one UTXO controlled by the Beacon Address. Beacon Signals commit to 32 bytes of information, called Signal Bytes, in the last UTXO of the transaction using the script `[OP_RETURN, OP_PUSHBYTES_32, <signalBytes>]`.

DID controllers can use BTC1 Beacons defined in their DID document to commit to, announce, and anchor in Bitcoin blocktime BTC1 Updates. We call these announcements, BTC1 Update Announcements.

The did:btc1 DID method specification defines three BTC1 Beacon Types: SingletonBeacon, MapBeacon and SMTBeacon. The Beacon Type determines how BTC1 Update Announcements are included within and can be validated against the Signal Bytes of a Beacon Signal.

In this demo we will be using the simplest Beacon Type to announce our BTC1 Update, the Singleton Beacon. In this case, the Signal Bytes of the Beacon Signal are the BTC1 Update Announcement.


Bitcoin blockchain
blockheight: 1
911929
911930
911931
TBD ...
BTC1 Beacon
{
"id":
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl#service-0",
"type": "SingletonBeacon",
"serviceEndpoint":
"bitcoin:tb1qtmshuqzeyr7cdh5t2nl6kf3s73fdynpj5apgtx"
}
Beacon Address
Identifies a Unspent Transaction Output (UTXO) controlled by the Beacon Address
Beacon Signal
Beacon Signals are broadcast to the Bitcoin network and anchored within a specific block in the Bitcoin blockchain
Bitcoin Transaction
Transaction Inputs
Previous Tx Identifier
Previous Index
Previous Tx Identifier
Previous Index
Transaction Outputs
Value
Script Public Key
0 BTC
[OP_RETURN, OP_PUSHBYTES_32, <signalBytes> ]

## 5.1 Identify a BTC1 Beacon defined in the source DID document that we will use to announce the BTC1 Update

[30]:
```python
btc1_beacon = v1_document["service"][0]

print("BTC1 Beacon\n", json.dumps(btc1_beacon, indent=2))
print("Beacon Type : ", btc1_beacon["type"])
beacon_address = btc1_beacon["serviceEndpoint"][8:]
print("Beacon Address : ", beacon_address)

print("Beacon Address Secret Key : ", singleton_sk)
```

```
BTC1 Beacon
 {
  "id": "did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl#
service-0",
  "type": "SingletonBeacon",
  "serviceEndpoint": "bitcoin:tb1qtmshuqzeyr7cdh5t2nl6kf3s73fdynpj5apgtx"
}
Beacon Type :  SingletonBeacon
Beacon Address :  tb1qtmshuqzeyr7cdh5t2nl6kf3s73fdynpj5apgtx
Beacon Address Secret Key :  <buidl.pecc.PrivateKey object at 0x71457a4bdee0>
```

### 5.2 Identify a UTXO controlled by the Beacon Address

You may need to fund the Beacon Address.

[31]:
```python
from buidl.tx import Tx, TxIn, TxOut

funding_tx_hex =␣
 ↪"01000000000101471290df0bc4e7b018beabdb1db41a0059197fb803384cc24133b40b04bba0f60100000000ff

tx = Tx.parse_hex(funding_tx_hex)
```

```
utxo_tx_id = tx.hash()
utxo_index = 0
utxo = tx.tx_outs[utxo_index]

controlling_address = tx.tx_outs[0].script_pubkey.address(network=network_type)
print(controlling_address)
print("Is controlled by Beacon Address : ", controlling_address ==␣
 ↪beacon_address)





# # utxo = TxIn(
# help(TxIn)
```

```
tb1qtmshuqzeyr7cdh5t2nl6kf3s73fdynpj5apgtx
Is controlled by Beacon Address :  True
```

[32]:
```
utxo_tx_id
```

[32]:
```
b'@\xdaY\xca\x00/x\x85\xf2\xb2\x01\x95\x12\x98~\xcf9+U\xdd\xa6\x95MniL\xaaC9,\xb
6u'
```

### 5.3 Construct the BTC1 Update Announcement

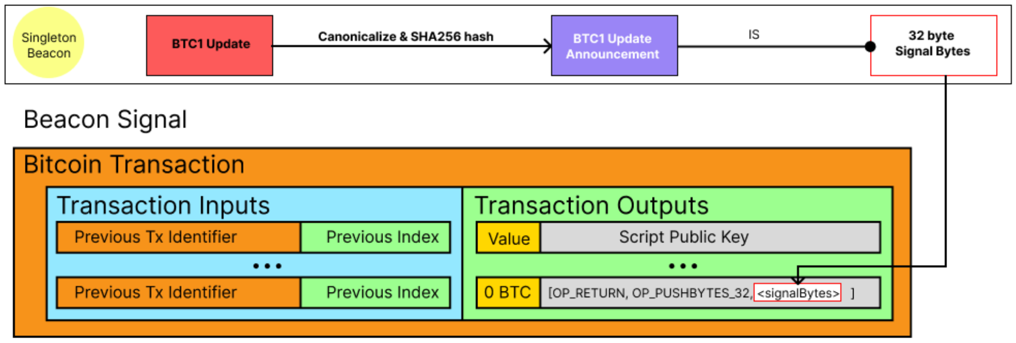
A BTC1 Update Announcement is a SHA256 hash of the canonicalized BTC1 Update.

[33]:
```
btc1_update_announcement = sha256(jcs.canonicalize(btc1_update))
```

### 5.4 Construct the Unsigned Singleton Beacon Signal

A Beacon Signal is a Bitcoin transaction which contains a set of transaction inputs and outputs with the following requirements:

- A least one transaction input is a UTXO controlled by the Beacon Address.
- The **last** transaction output contains the Signal Bytes in the form `[OP_RETURN, OP_PUSHBYTES_32, <signalBytes>]`.
- The Signal Bytes is the BTC1 Update Announcement.



[34]:
```python
from buidl.script import ScriptPubKey

# Transaction input that spends a UTXO controlled by the Beacon Address
tx_in = TxIn(prev_tx=utxo_tx_id, prev_index=utxo_index)
tx_in._value = utxo.amount
tx_in._script_pubkey = utxo.script_pubkey
# Construct transaction inputs
tx_ins = [tx_in]

# Fee for the Bitcoin transaction
tx_fee = 4000

# Refund the remaining UTXO value to the beacon_script
refund_amount = tx_in.value() - tx_fee
refund_script_pubkey = beacon_script
refund_out = TxOut(amount=refund_amount, script_pubkey=refund_script_pubkey)

# Construct the TxOut that contains the Signal Bytes committing to the BTC1␣
↪Update
signal_bytes_script_pubkey = ScriptPubKey([0x6a, btc1_update_announcement])
beacon_signal_bytes_txout = TxOut(0, signal_bytes_script_pubkey)

# Construct transaction outputs. The last output MUST be the signal bytes␣
↪commitment
tx_outs = [refund_out, beacon_signal_bytes_txout]

beacon_signal = Tx(version=1, tx_ins=tx_ins, tx_outs=tx_outs,␣
↪network=network_type, segwit=True)
```

### 5.5 Sign Beacon Signal

[35]:
```
result = beacon_signal.sign_input(0, singleton_sk)
result
```

[35]:
```
True
```

[36]:
```
beacon_signal.serialize().hex()
```

[36]:
```
'0100000000010175b62c3943aa4c696e4d95a6dd552b39cf7e98129501b2f285782f00ca59da400
000000000ffffffff02a08c000000000000001600145ee17e005920fd86de8b54ffab2630f452d24c3
2000000000000000226a205bbfde57ae20100ea79f84189fd69451a37aac2e3f8d0122f902f0006
1a1bc20024730440220317aa656fe25f6606e3a799e47f7c2ea895d813fbde869f62710b3733aae5
60b02204880bcd1daac214bb3a38deef72b142b0e5b2691cac7fb7055e7365d15b7acc201210324e
e967d8495aec7e15ad5509db305f8c84792452d8ba5cb5eb0f3ea12aeb9fb00000000'
```

### 5.6 Broadcast Beacon Signal

Ideally, the Beacon Signal would be broadcast to a Bitcoin node under your control. However we will just be using the public API: https://mutinynet.com/tx/push

## NOTE: PLEASE DO NOT TRY TO BROADCAST THIS SIGNAL YET!

[37]:
```
sidecar_data
```

[37]:
```
{'initialDocument': {'@context': ['https://www.w3.org/TR/did-1.1',
   'https://did-btc1/TBD/context'],
  'id':
'did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl',
  'verificationMethod': [{'id':
'did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl#key-0',
    'type': 'Multikey',
    'controller':
'did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl',
    'publicKeyMultibase': 'zQ3shSnvxNK94Kpux1sp8RCWfn4dTFcAr1fZLf7E3Dy19mEBi'}],
  'assertionMethod': ['did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cj
pfqjdey2qxfgl#key-0'],
  'capabilityInvocation': ['did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908
cm7cjpfqjdey2qxfgl#key-0'],
  'service': [{'id': 'did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjp
fqjdey2qxfgl#service-0',
    'type': 'SingletonBeacon',
    'serviceEndpoint': 'bitcoin:tb1qtmshuqzeyr7cdh5t2nl6kf3s73fdynpj5apgtx'}]}}
```

## 6. Resolve updated did:btc1 identifier using the universal resolver

We will again use the universal resolver to resolve this updated did:btc1 identifier. As mentioned earlier, the structure of the Sidecar Data is likely to change.

### 6.1 Construct Sidecar Data for Beacon Signal

[40]:
```
signal_sidecar_data = {}
signal_sidecar_data["updatePayload"] = btc1_update

print(json.dumps(signal_sidecar_data, indent=2))
```

```
{
  "updatePayload": {
    "@context": [
      "https://w3id.org/security/v2",
      "https://w3id.org/zcap/v1",
      "https://w3id.org/json-ld-patch/v1"
    ],
    "patch": [
      {
        "op": "add",
        "path": "/verificationMethod/1",
        "value": {
          "id":
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl#key-1",
          "type": "Multikey",
          "controller":
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl",
          "publicKeyMultibase":
"zQ3shSnvxNK94Kpux1sp8RCWfn4dTFcAr1fZLf7E3Dy19mEBi"
        }
      },
      {
        "op": "add",
        "path": "/authentication",
        "value": [
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl#key-1"
        ]
      }
    ],
    "sourceHash": "GQi1k4ATu3k3UBhES7b8m45U7edzqB3fSRCX9hp83kmb",
    "targetHash": "YBxGFw1r4PwjoNBGEfgvvEntGKGXpYDz2XFPNgTweba",
    "targetVersionId": 2,
    "proof": {
      "type": "DataIntegrityProof",
      "cryptosuite": "bip340-jcs-2025",
      "verificationMethod":
```

```
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl#key-0",
      "proofPurpose": "capabilityInvocation",
      "capability": "urn:zcap:root:did%3Abtc1%3Ax1q46eavlryfkgs3wy0tkzpcr745vxdu
e6zl04kz908cm7cjpfqjdey2qxfgl",
      "capabilityAction": "Write",
      "@context": [
        "https://w3id.org/security/v2",
        "https://w3id.org/zcap/v1",
        "https://w3id.org/json-ld-patch/v1"
      ],
      "proofValue": "z5kdS3pqKroucErsUgMoTsquvV5QVHNJZtTu4c4GcjR2T26tNihacbvYxbC
fybjBakMMgy3uSFCZrqvBjuLT5kWSE"
    }
  }
}
```

## 6.2 Construct Signals Metadata Map

[41]:
```
signals_metadata = {}
signal_id = beacon_signal.id()
signals_metadata[signal_id] = signal_sidecar_data
```

## 6.3 Add Signals Metadata Map to Sidecar Data

[42]:
```
sidecar_data["signalsMetadata"] = signals_metadata
```

```
{
  "initialDocument": {
    "@context": [
      "https://www.w3.org/TR/did-1.1",
      "https://did-btc1/TBD/context"
    ],
    "id":
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl",
    "verificationMethod": [
      {
        "id":
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl#key-0",
        "type": "Multikey",
        "controller":
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl",
        "publicKeyMultibase":
"zQ3shSnvxNK94Kpux1sp8RCWfn4dTFcAr1fZLf7E3Dy19mEBi"
      }
    ],
    "assertionMethod": [
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl#key-0"
    ],
    "capabilityInvocation": [
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl#key-0"
    ],
    "service": [
      {
        "id": "did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2
qxfgl#service-0",
        "type": "SingletonBeacon",
        "serviceEndpoint": "bitcoin:tb1qtmshuqzeyr7cdh5t2nl6kf3s73fdynpj5apgtx"
      }
    ]
  },
  "signalsMetadata": {
    "670046836408591297798c71b521415ab0ede54f327bc5d9f3237b2b7a3657c9": {
      "updatePayload": {
        "@context": [
          "https://w3id.org/security/v2",
          "https://w3id.org/zcap/v1",
          "https://w3id.org/json-ld-patch/v1"
        ],
        "patch": [
          {
            "op": "add",
            "path": "/verificationMethod/1",
            "value": {
              "id":
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl#key-1",
              "type": "Multikey",
              "controller":
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl",
              "publicKeyMultibase":
"zQ3shSnvxNK94Kpux1sp8RCWfn4dTFcAr1fZLf7E3Dy19mEBi"
            }
          },
          {
            "op": "add",
            "path": "/authentication",
            "value": [
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl#key-1"
            ]
          }
        ],
        "sourceHash": "GQi1k4ATu3k3UBhES7b8m45U7edzqB3fSRCX9hp83kmb",
        "targetHash": "YBxGFw1r4PwjoNBGEfgvvEntGKGXpYDz2XFPNgTweba",
        "targetVersionId": 2,
        "proof": {
          "type": "DataIntegrityProof",
          "cryptosuite": "bip340-jcs-2025",
          "verificationMethod":
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl#key-0",
          "proofPurpose": "capabilityInvocation",
          "capability": "urn:zcap:root:did%3Abtc1%3Ax1q46eavlryfkgs3wy0tkzpcr745
vxdue6zl04kz908cm7cjpfqjdey2qxfgl",
          "capabilityAction": "Write",
          "@context": [
            "https://w3id.org/security/v2",
            "https://w3id.org/zcap/v1",
            "https://w3id.org/json-ld-patch/v1"
          ],
          "proofValue": "z5kdS3pqKroucErsUgMoTsquvV5QVHNJZtTu4c4GcjR2T26tNihacbv
YxbCfybjBakMMgy3uSFCZrqvBjuLT5kWSE"
        }
      }
    }
  }
}
```

## 6.4 Define DID Resolution Options

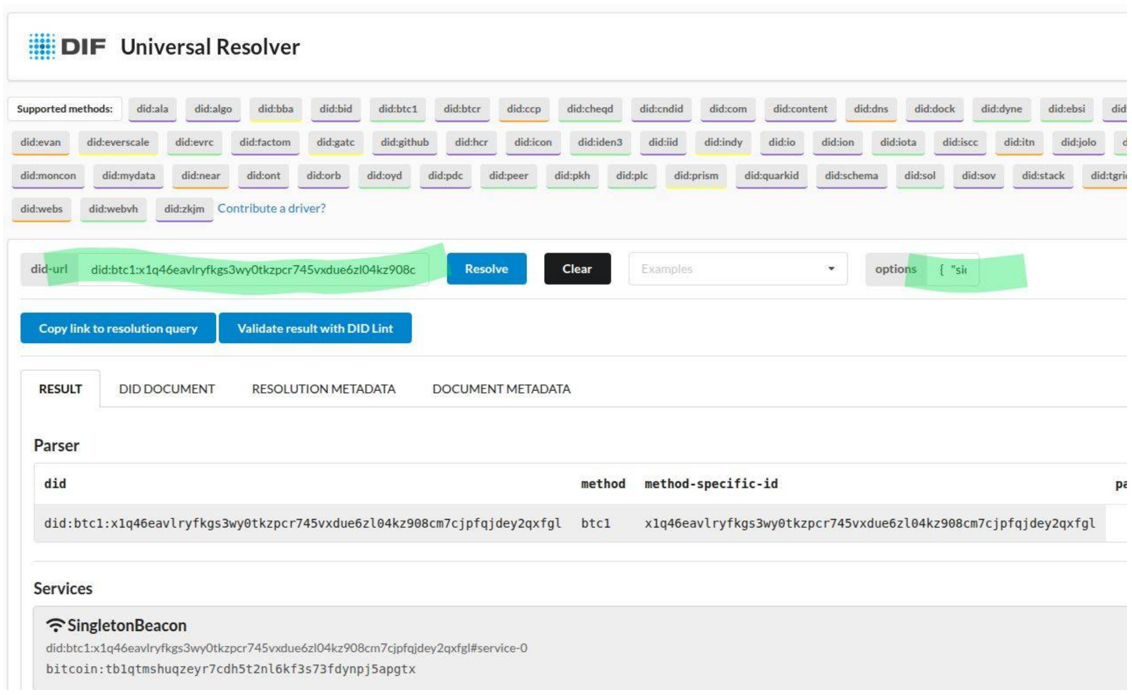
[45]:
```python
resolution_options = {}
resolution_options["sidecarData"] = sidecar_data

print(json.dumps(resolution_options, indent=2))
```

```
{
  "sidecarData": {
    "initialDocument": {
      "@context": [
        "https://www.w3.org/TR/did-1.1",
        "https://did-btc1/TBD/context"
      ],
      "id":
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl",
      "verificationMethod": [
        {
          "id":
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl#key-0",
          "type": "Multikey",
          "controller":
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl",
          "publicKeyMultibase":
"zQ3shSnvxNK94Kpux1sp8RCWfn4dTFcAr1fZLf7E3Dy19mEBi"
        }
      ],
      "assertionMethod": [
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl#key-0"
```

```
      ],
      "capabilityInvocation": [
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl#key-0"
      ],
      "service": [
        {
          "id": "did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjde
y2qxfgl#service-0",
          "type": "SingletonBeacon",
          "serviceEndpoint":
"bitcoin:tb1qtmshuqzeyr7cdh5t2nl6kf3s73fdynpj5apgtx"
        }
      ]
    },
    "signalsMetadata": {
      "670046836408591297798c71b521415ab0ede54f327bc5d9f3237b2b7a3657c9": {
        "updatePayload": {
          "@context": [
            "https://w3id.org/security/v2",
            "https://w3id.org/zcap/v1",
            "https://w3id.org/json-ld-patch/v1"
          ],
          "patch": [
            {
              "op": "add",
              "path": "/verificationMethod/1",
              "value": {
                "id":
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl#key-1",
                "type": "Multikey",
                "controller":
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl",
                "publicKeyMultibase":
"zQ3shSnvxNK94Kpux1sp8RCWfn4dTFcAr1fZLf7E3Dy19mEBi"
              }
            },
            {
              "op": "add",
              "path": "/authentication",
              "value": [
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl#key-1"
              ]
            }
          ],
          "sourceHash": "GQi1k4ATu3k3UBhES7b8m45U7edzqB3fSRCX9hp83kmb",
          "targetHash": "YBxGFw1r4PwjoNBGEfgvvEntGKGXpYDz2XFPNgTweba",
          "targetVersionId": 2,
          "proof": {
            "type": "DataIntegrityProof",
            "cryptosuite": "bip340-jcs-2025",
            "verificationMethod":
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl#key-0",
            "proofPurpose": "capabilityInvocation",
            "capability": "urn:zcap:root:did%3Abtc1%3Ax1q46eavlryfkgs3wy0tkzpcr7
45vxdue6zl04kz908cm7cjpfqjdey2qxfgl",
            "capabilityAction": "Write",
            "@context": [
              "https://w3id.org/security/v2",
              "https://w3id.org/zcap/v1",
              "https://w3id.org/json-ld-patch/v1"
            ],
            "proofValue": "z5kdS3pqKroucErsUgMoTsquvV5QVHNJZtTu4c4GcjR2T26tNihac
bvYxbCfybjBakMMgy3uSFCZrqvBjuLT5kWSE"
          }
        }
      }
    }
  }
}
```

## 6.5 Execute a Resolution Request using the Universal Resolver

1. Visit the Universal Resolver.
2. Paste in the did:btc1 identifier and the resolution_options object (printed below) into the respective fields.
3. Execute a Resolution Request (click the resolve button).



did-url: did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908c

options: { "si

Parser

| did | method | method-specific-id |
|---|---|---|
| did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl | btc1 | x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl |

Services

SingletonBeacon
did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl#service-0
bitcoin:tb1qtmshuqzeyr7cdh5t2nl6kf3s73fdynpj5apgtx

```
[47]: print(btc1_identifier)
```

```
did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl
```

```
[48]: print(json.dumps(resolution_options, indent=2))
```

```
{
  "sidecarData": {
    "initialDocument": {
      "@context": [
        "https://www.w3.org/TR/did-1.1",
        "https://did-btc1/TBD/context"
      ],
      "id":
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl",
      "verificationMethod": [
        {
          "id":
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl#key-0",
          "type": "Multikey",
          "controller":
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl",
          "publicKeyMultibase":
"zQ3shSnvxNK94Kpux1sp8RCWfn4dTFcAr1fZLf7E3Dy19mEBi"
        }
      ],
      "assertionMethod": [
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl#key-0"
      ],
      "capabilityInvocation": [
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl#key-0"
      ],
      "service": [
        {
          "id": "did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjde
y2qxfgl#service-0",
          "type": "SingletonBeacon",
          "serviceEndpoint":
"bitcoin:tb1qtmshuqzeyr7cdh5t2nl6kf3s73fdynpj5apgtx"
        }
      ]
    },
    "signalsMetadata": {
      "6700468364085912977 98c71b521415ab0ede54f327bc5d9f3237b2b7a3657c9": {
        "updatePayload": {
          "@context": [
            "https://w3id.org/security/v2",
            "https://w3id.org/zcap/v1",
            "https://w3id.org/json-ld-patch/v1"
          ],
          "patch": [
            {
              "op": "add",
              "path": "/verificationMethod/1",
              "value": {
                "id":
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl#key-1",
                "type": "Multikey",
                "controller":
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl",
                "publicKeyMultibase":
"zQ3shSnvxNK94Kpux1sp8RCWfn4dTFcAr1fZLf7E3Dy19mEBi"
              }
            },
            {
              "op": "add",
              "path": "/authentication",
              "value": [
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl#key-1"
              ]
            }
          ],
          "sourceHash": "GQi1k4ATu3k3UBhES7b8m45U7edzqB3fSRCX9hp83kmb",
          "targetHash": "YBxGFw1r4PwjoNBGEfgvvEntGKGXpYDz2XFPNgTweba",
          "targetVersionId": 2,
          "proof": {
            "type": "DataIntegrityProof",
            "cryptosuite": "bip340-jcs-2025",
            "verificationMethod":
"did:btc1:x1q46eavlryfkgs3wy0tkzpcr745vxdue6zl04kz908cm7cjpfqjdey2qxfgl#key-0",
            "proofPurpose": "capabilityInvocation",
            "capability": "urn:zcap:root:did%3Abtc1%3Ax1q46eavlryfkgs3wy0tkzpcr7
45vxdue6zl04kz908cm7cjpfqjdey2qxfgl",
            "capabilityAction": "Write",
            "@context": [
              "https://w3id.org/security/v2",
              "https://w3id.org/zcap/v1",
              "https://w3id.org/json-ld-patch/v1"
            ],
            "proofValue": "z5kdS3pqKroucErsUgMoTsquvV5QVHNJZtTu4c4GcjR2T26tNihac
bvYxbCfybjBakMMgy3uSFCZrqvBjuLT5kWSE"
          }
        }
      }
    }
  }
```

```
}
```

```
[ ]:
```