Bitcoin Core:
The Reference Client

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Outline

- Overview of Implementations
- Bitcoin Core Interfaces
  - GUI
  - **RPC**
  - REST
  - P2P
- Overview of Code
- Compiling Options

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Full Node Implementations

- **Bitcoin Core** – the original, reference client
- btcd
- rust-bitcoin
- BitcoinJ
- bitcore
- BitcoinJS
- libbitcoin
- libcoin
- python-bitcoinlib
- caesure

...And many others

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Testnet/Mainnet

- Mainnet is The Real Bitcoin Blockchain
- Testnet is similar to mainnet, with a few differences:
  - Difficulty resets often so it is easier to mine
  - More total “bitcoins”
  - Addresses have a different format
  - Useful for testing so you don't risk losing real bitcoins
- Regtest: Useful for automated testing
- Bitcoin Core (and most others) support both

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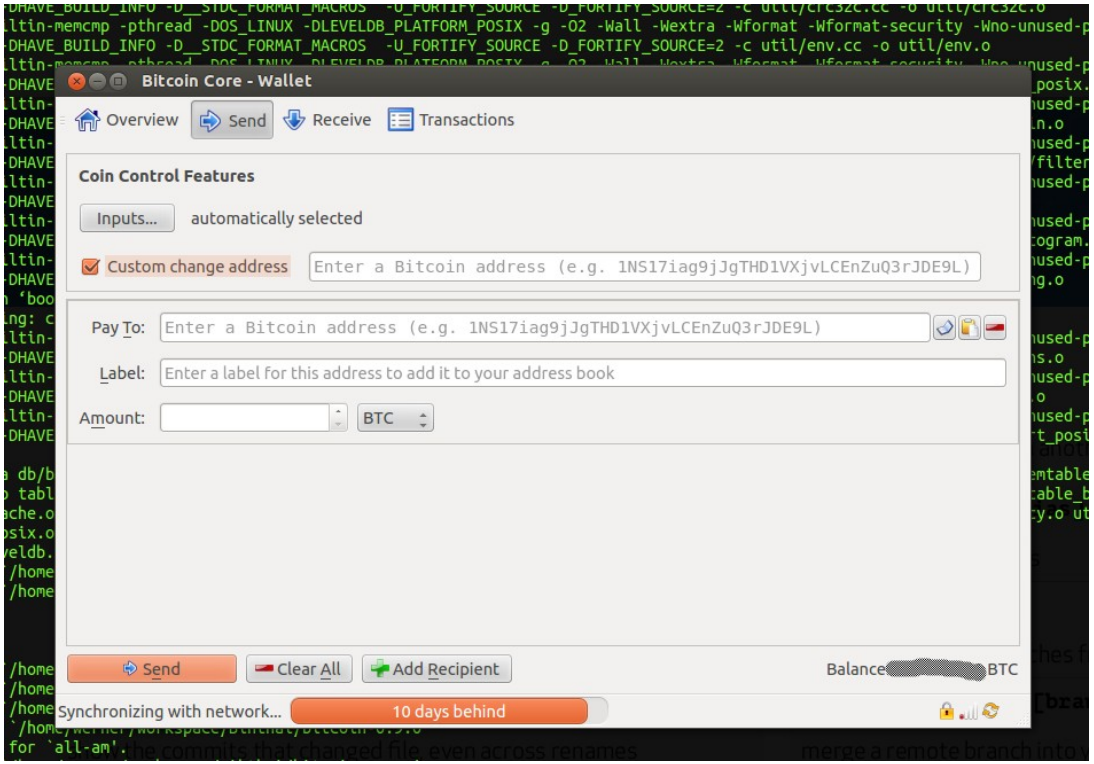
GUI

- Useful if you want to use Bitcoin Core as a personal wallet
- Gets in the way if you want to use Bitcoin Core as a service – which is usually what you want



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RPC

- JSON-RPC: Remote Procedure Call using JSON as the data format
- Client → JSON command + args → Server
- Server → JSON response → Client
- Can control/monitor blocks, transactions, p2p, wallet, mining

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RPC: Blocks

- getbestblockhash
- Return the id of the highest block of the longest chain, i.e. the tip of the blockchain

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RPC: Blocks

- getblock “hash”
- Returns the hex content of a block with id “hash”

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RPC: Blocks

- getblockchaininfo
- Returns some info:


```
{
   "chain" : "main",
   "blocks" : 365579,
   "headers" : 365579,
   "bestblockhash" : "00000000000000003307984a0ff7b9da42bf6f8b3ca01dd1c632d1e4e019424",
   "difficulty" : 51076366303.48192596,
   "verificationprogress" : 0.99697552,
   "chainwork" : "0000000000000000000000000000000000000000000878ccb6e6742f9f48f2a8",
   "pruned" : false
}
```


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RPC: Blocks

- getblockcount
- Returns the number of blocks, e.g. 365579

RPC: Blocks

- getchaintips
- Returns information on orphaned block tips, in case there has ever been a reorg (which does happen occasionally)

RPC: Blocks

- getdifficulty
- Get current mining difficulty. i.e., if you are mining, you need to find a block of greater difficulty than this.

RPC: Blocks

- getmempoolinfo

- Returns information on the memory pool, including number of transactions in the pool. This is how many transactions are valid and have been seen by this node, but have not yet been placed into a block.

RPC: Blocks

- getrawmempool
- If for some reason you want to see the actual transactions in the mempool, you can see them with this command.

RPC: Blocks

- gettxout “txid” n
- Get the nth transaction output of transaction id “txid”

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RPC: Blocks

- gettxoutproof ["txid",...] (blockhash)
- Returns a “proof” that a transaction was contained in a block, i.e. the block hash, merkle root, merkle proof and the transaction id in that proof. Will be useful for sidechains.

RPC: Blocks

- gettxoutsetinfo

- Returns statistics about the transaction output set info.


```
{
   "height" : 365579,
   "bestblock" :
"000000000000000003307984a0ff7b9da42bf6f8b3ca01dd1c632d1e4e019424",
   "transactions" : 6791042,
   "txouts" : 25322317,
   "bytes_serialized" : 869218481,
   "hash_serialized" :
"844885bfae7f9c206fbfc2670c6d513f11b1670e759841cb720aeee4c6b590cf",
   "total_amount" : 14389339.76669114
}
```


-

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RPC: Blocks

- verifychain (checklevel numblocks)

- Verify the block chain database. i.e., if you have downloaded the blockchain from a torrent rather than from the usual p2p protocol, and want to manually verify.

RPC: Blocks

- verifytxoutproof
- Verify that a transaction output proof is valid, i.e. that an output is in the blockchain. This is the complement of gettxoutproof.

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RPC: Control

- getinfo – general info about this Bitcoin Core
- help – get info on a command
- stop – stop the node

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RPC: Generating

- generate numblocks

- Immediately mine a block – only for use in regtest mode. This is useful for testing is any changes you have made to bitcoin core are working correctly, i.e. haven't broken the regression tests.

RPC: Generating

- getgenerate
- Returns true if node is set to mine, or false if node is not set to mine.

RPC: Generating

- setgenerate generate (genproclimit)

- Turn on or off CPU-mining. Normally you would not want to turn this on, as CPU mining is too slow. However, this can be useful for testing purposes.

RPC: Mining

- getblocktemplate ("jsonrequestobject")

- Returns some JSON data that you can use to mine the current block. Includes current transactions in the mempool and block header information.

RPC: Mining

- getmininginfo

- Returns some generic information about the mining status of this node.


```
{
   "blocks" : 365579,
   "currentblocksize" : 0,
   "currentblocktx" : 0,
   "difficulty" : 51076366303.48192596,
   "errors" : "",
   "genproclimit" : -1,
   "networkhashps" : 332012768879098752,
   "pooledtx" : 0,
   "testnet" : false,
   "chain" : "main",
   "generate" : false
}
```


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RPC: Mining

- getnetworkhashps
- Get the current number of hashes per second of the network, e.g. 33201276887909875 2

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RPC: Mining

- prioritisetransaction <txid> <priority delta> <fee delta>

- Accept this transaction into a block at a higher priority. Useful if mining and blocks are full, but want to accept a particular transaction sooner.

RPC: Mining

- submitblock "hexdata"
  ("jsonparametersobject")

- If you have found a block, submit the block to the network.

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RPC: P2P

- addnode "node" "add|remove|onetry"

- To connect or disconnect to another node. Useful if it's one of your nodes or another node that you know you can reliably connect to.

RPC: P2P

- getaddednodeinfo dns ("node")

- Get information about nodes that we have added, such as IP address and whether we are connected or not. “dns” is either true or false; if false, won't show disconnected nodes.

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RPC: P2P

- getconnectioncount
- How many p2p connections, e.g. 8.

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RPC: P2P

- getnettotals
- How many bytes in, bytes out, and CPU time spent on network.

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RPC: P2P

- getnetworkinfo
- Return misc. information about the network, such as version number, services offered to network, local addresses.

RPC: P2P

- getpeerinfo
- Return misc. information about each peer, such as their protocol version, bytes sent/received, services offered.

RPC: P2P

- ping
- Commands a ping to be sent to all peers so that we can measure the ping/pong time (info returned by getpeerinfo)

RPC: transactions

- createrawtransaction [{"txid":"id","vout":n},...] {"address":amount,...}

- Pass in inputs and output address/amount, and it creates an unsigned transaction sending to that address.

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RPC: transactions

- decoderawtransaction "hexstring"
- Presents a JSON-formatted version of a transaction; very useful for debugging a transaction that is invalid for an unknown reason.

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RPC: transactions

- decodescript "hex"
- Presents a string-formatted version of a script; very useful for investigating hex-encoded scripts.

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RPC: transactions

- getrawtransaction "txid" (verbose)
- Get the transaction from the transaction id – must have transaction index enabled for this to work reliably.

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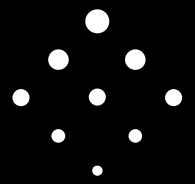

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RPC: transactions

- sendrawtransaction "hexstring"
  (allowhighfees)

- Broadcast a transaction to the network. e.g., if you have created the transaction using separate wallet software, this can be used to actually broadcast the signed transaction.

RPC: transactions

- signrawtransaction "hexstring" ([{"txid":"id","vout":n,"scriptPubKey":"hex","redeemScript":"hex"},...] ["privatekey1",...] sighashtype)

- Add signatures to a transaction. Only works if you have the private keys. Works with multisig!

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RPC: Util

- createmultisig nrequired ["key",...]
- Create the redeemScript for an m-of-n multisig tx.

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RPC: Util

- estimatefee nblocks

- Estimate fee per kilobyte needed for the transaction to be accepted in nblocks, based on how long it took recent transactions to make it into a block.

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RPC: Util

- estimatepriority nblocks

- Estimate the “priority” a 0-fee transaction needs to be accepted in nblocks. The “priority” is based on size of and number of inputs/outputs. Larger valued, simpler transactions have higher priority.

RPC: Util

- validateaddress "bitcoinaddress"
- Validate that an address is a valid bitcoin address.

RPC: Util

- validatemessage "bitcoinaddress" "signature" "message"

- Validate that a message signed with a bitcoin address is valid. This method is mostly unrelated to transaction signing and verification; it is the analog of the signmessage method.

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RPC: Wallet

- addmultisigaddress nrequired ["key",...] ("account")
- Add a multisig address so that the wallet knows to watch for it.

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RPC: Wallet

- backupwallet "destination"
- Copy the wallet.dat file to a destination folder or file for backup.

RPC: Wallet

- backupwallet "destination"
- Copy the wallet.dat file to a destination folder or file for backup.

RPC: Wallet

- dumpprivkey "bitcoinaddress"
- Show the private key for a bitcoin address (obviously only works for addresses to which the private key is in the wallet)

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RPC: Wallet

- dumpwallet "filename"
- Dump entire wallet, including addresses and private keys, to a human-readable file.

RPC: Wallet

- encryptwallet "passphrase"

- If the wallet file is not already encrypt it, encrypts all private keys with the password “passphrase”. You should (obviously) make use of this feature if the wallet holds real bitcoin.

RPC: Wallet

- encryptwallet "passphrase"

- If the wallet file is not already encrypt it, encrypts all private keys with the password “passphrase”. You should (obviously) make use of this feature if the wallet holds real bitcoin.

RPC: Wallet

- getaccount "bitcoinaddress"
- Returns the name of the “account” associated with the bitcoin address – concerns the deprecated “account” feature of wallets.

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RPC: Wallet

- getaccountaddress "account"
- Get the current receiving address for an “account.” Deprecated.

RPC: Wallet

- getaddressesbyaccount "account"
- Get addresses for an “account”. Deprecated.

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RPC: Wallet

- getbalance ("account" minconf includeWatchonly)

- Get total balance of wallet (also works for the balance of an “account” - deprecated). Can specify mininum confirms, e.g. 1 to not include 0-confirms.

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RPC: Wallet

- getnewaddress ("account")
- Get a new address for receiving bitcoin.

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RPC: Wallet

- getrawchangeaddress
- Get a new address for change, specifically for use with createrawtransaction and related raw transactions, not for receiving bitcoin normally.

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RPC: Wallet

- getreceivedbyaccount "account" (minconf)
- Get total amount received at an account, with optional min confirms. Deprecated.

RPC: Wallet

- getreceivedbyaddress "bitcoinaddress" (minconf)
- Get total amount received at an address, with optional min confirms.

RPC: Wallet

- gettransaction "txid" (includeWatchonly)
- Get JSON-formatted transaction of id txid.

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RPC: Wallet

- getunconfirmedbalance
- Get the balance of bitcoin not yet confirmed, i.e. 0-confirms.

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RPC: Wallet

- getwalletinfo
- Returns misc. information about the wallet, such as balance, version, transaction count.

RPC: Wallet

- getwalletinfo
- Returns misc. information about the wallet, such as balance, version, transaction count.

RPC: Wallet

- importprivkey "bitcoinprivkey" ("label" rescan)

- Import a private key into the wallet. Specify rescan=true to be sure to scan the blockchain to pick up any unspents.

RPC: Wallet

- importwallet "filename"
- Import a human-readable wallet, including private keys. The complement of exportwallet.

RPC: Wallet

- keypoolrefill (newsize)

- Bitcoin Core maintains a pool of private keys to access, so that you do not need to backup the wallet every time you generate a new private key. This increases the size of the pool to newsize. You should backup after using this command.

RPC: Wallet

- listaccounts (minconf includeWatchonly)
- List accounts and their respective balances . Deprecated.

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RPC: Wallet

- listaddressgroupings

- List addresses grouped by whether they were used on the same inputs to a transaction, i.e. they are publicly “grouped”.

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RPC: Wallet

- listlockunspent
- List transactions that are “locked” and cannot be spent. See lockunspent.

RPC: Wallet

- listreceivedbyaccount (minconf includeempty includeWatchonly)

- List received by account. Deprecated.

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RPC: Wallet

- listreceivedbyaddress (minconf includeempty includeWatchonly)

- List received by address, useful to see how balance is distributed across addresses.

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RPC: Wallet

- listsinceblock ("blockhash" target-confirmations includeWatchonly)

- List all transactions in the wallet since block of id blockhash.

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RPC: Wallet

- listtransactions ("account" count from includeWatchonly)

- List all transactions in the wallet up to “count”, starting from “from”. The “account” portion is deprecated and should always be “*”.

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RPC: Wallet

- listunspent (minconf maxconf ["address",...])

- Returns an array of unspent transaction outputs. Useful for separate wallet software to build transactions without maintaining its own list of unspents.

RPC: Wallet

- lockunspent unlock [{"txid":"txid","vout":n},...]

- Lock an unspent so that it can't be spent. Useful if you wish to guarantee a certain number of confirms before spending the unspent. See also listlockunspent.

RPC: Wallet

- move "fromaccount" "toaccount" amount (minconf "comment")

- Deprecated.

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RPC: Wallet

- sendfrom "fromaccount" "tobitcoinaddress" amount (minconf "comment" "comment-to")

- Send from a specific account to a bitcoin address. Deprecated – use sendtoaddress.

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RPC: Wallet

- sendmany "fromaccount" {"address":amount,...} (minconf "comment" ["address",...])

- Send from a specific account to a bitcoin address. Deprecated.

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RPC: Wallet

- sendtoaddress "bitcoinaddress" amount ("comment" "comment-to" subtractfeefromamount)

- Send an amount to a bitcoin address.

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RPC: Wallet

- setaccount "bitcoinaddress" "account"
- Set which account a bitcoin address belongs to. Deprecated.

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RPC: Wallet

- settxfee amount
- Set the transaction fee per kb to be used in methods such as sendtoaddress.

RPC: Wallet

- signmessage "bitcoinaddress" "message"

- Sign a message with a bitcoin address. Useful for proving ownership of a specific address without broadcasting a transaction. See also verifymessage.

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REST

- Less powerful than RPC, but arguably nicer interface.
- Can get information about:
  - Transactions
  - Blocks
  - Chain status
  - UTXOs (unspents)

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P2P

- Bitcoin Core, of course, communicates with other peers via the p2p protocol
- Normally the RPC interface will suffice, but sometimes you may want to use the p2p protocol to your own instance of Bitcoin Core
- ...there will be a whole talk about this later this week.

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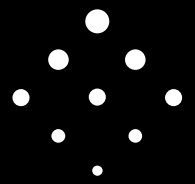

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Code

- Some important files:
  - main.cpp – main code that initiates everything, including wallet, block chain db, network connections (see main() in bitcoind.cpp and qt/bitcoin.cpp)
  - script/interpreter.cpp – script interpreter