```
intrp    /lib64/ld-linux-x86-64.so.2
bintype  elf
class    ELF64
lang     c
arch     x86
bits     64
machine  AMD x86-64 architecture
os       linux
minopsz  1
maxopsz  16
pcalign  0
subsys   linux
endian   little
stripped true
static   false
linenum  false
lsyms    false
relocs   false
rpath    NONE
binsz    29504
```

```
[0x004013d0 16% 320 /bin/true]> x @ entry0
- offset -   0 1  2 3  4 5  6 7  8 9  A B  C D  E
0x004013d0  31ed 4989 d15e 4889 e248 83e4 f050 544
0x004013e0  c7c0 3044 4000 48c7 c1c0 4340 0048 c7c
0x004013f0  3013 4000 ff15 f65b 2000 f40f 1f44 000
0x00401400  b81f 7260 0055 482d 1872 6000 4883 f80
0x00401410  4889 e576 1bb8 0000 0000 4885 c074 115
0x00401420  bf18 7260 00ff e066 0f1f 8400 0000 000
0x00401430  5dc3 0f1f 4000 662e 0f1f 8400 0000 000
0x00401440  be18 7260 0055 4881 ee18 7260 0048 c1f
0x00401450  0348 89e5 4889 f048 c1e8 3f48 01c6 48d
0x00401460  fe74 15b8 0000 0000 4885 c074 0b5d bf1
0x00401470  7260 00ff e00f 1f00 5dc3 660f 1f44 000
0x00401480  803d c15d 2000 0075 1155 4889 e5e8 6ef
0x00401490  ffff 5dc6 05ae 5d20 0001 f3c3 0f1f 400
0x004014a0  bf18 6e60 0048 833f 0075 05eb 930f 1f0
0x004014b0  b800 0000 0048 85c0 74f1 5548 89e5 ffd
0x004014c0  5de9 7aff ffff 662e 0f1f 8400 0000 000
0x004014d0  4154 55ba 0500 0000 53be 4845 4000 89f
0x004014e0  31ff 4883 c480 488b 2d73 5d20 0064 488
```

```
0x00405100 6 str.POSIX
0x00405106 6 str.ASCII
0x0040510c 9 str._usr_lib
0x00405115 16 str.CHARSETALIASDIR
0x00405125 10 str._50s__50s
0x00401330 256 main
0x004013d0 1 entry0
0x00000000 0 section.
0x00000000 0 section_end.
0x00400238 28 section..interp
0x00400254 0 section_end..interp
0x00400254 32 section..note.ABI_tag
0x00400274 0 section_end..note.ABI_tag
0x00400274 36 section..note.gnu.build_id
0x00400298 0 section_end..note.gnu.build_id
0x00400298 92 section..gnu.hash
0x004002f4 0 section_end..gnu.hash
0x004002f8 1320 section..dynsym
0x00400820 0 section_end..dynsym
0x00400820 587 section..dynstr
```

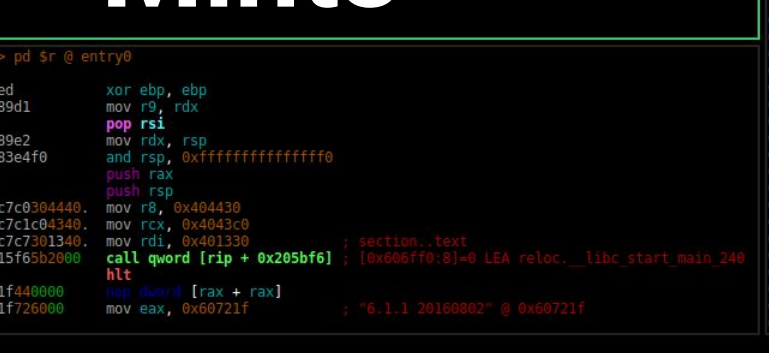
```
[0x00401330 15% 87 /bin/true]> pd $r @ main
          ;-- section_end..plt:
          ;-- section..text:
/ (fcn) main 160
|         ; DATA XREF from 0x004013ed (entry0)
|         0x00401330      83ff02         cmp edi, 2                  ; [13] va=0x00401330 pa=0x00001330 sz=12601 vsz=
|       ,=< 0x00401333      7403           je 0x401338                 ;[1]
|       |   0x00401335      31c0           xor eax, eax
|       |   0x00401337      c3             ret
|       |   ; JMP XREF from 0x00401333 (main)
|       `-> 0x00401338      53             push rbx
|           0x00401339      488b3e         mov rdi, qword [rsi]
|           0x0040133c      4889f3         mov rbx, rsi
|           0x0040133f      e84c050000     call sub.fwrite_890         ;[2]
|           0x00401344      be8d444000     mov esi, 0x40448d
|           0x00401349      bf06000000     mov edi, 6
```

Federated Chaumian Mints

```
[0x004013d0 16% 256 /bin/true]> pd $r @ entry0
          ;-- entry0:
          0x004013d0      31ed           xor ebp, ebp
          0x004013d2      4989d1         mov r9, rdx
          0x004013d5      5e             pop rsi
          0x004013d6      4889e2         mov rdx, rsp
          0x004013d9      4883e4f0       and rsp, 0xfffffffffffffff0
          0x004013dd      50             push rax
          0x004013de      54             push rsp
          0x004013df      49c7c0304440.  mov r8, 0x404430
          0x004013e6      48c7c1c04340.  mov rcx, 0x4043c0
          0x004013ed      48c7c7301340.  mov rdi, 0x401330           ; section..text
          0x004013f4      ff15f65b2000   call qword [rip + 0x205bf6] ; [0x606ff0:8]=0 LEA reloc._libc_start_main_240
          0x004013fa      f4             hlt
          0x004013fb      0f1f440000     nop dword [rax + rax]
          0x00401400      b81f726000     mov eax, 0x60721f           ; "6.1.1 20160802" @ 0x60721f
```

```
|Usage: px[afoswqWqQ][f] # Print heXadecimal
| px        show hexdump
| px/       same as x/ in gdb (help x)
| pxa       show annotated hexdump
| pxA       show op analysis color map
| pxb       dump bits in hexdump form
| pxd[124]  signed integer dump (1 byte, 2 and 4)
| pxe       emoji hexdump! :)
| pxi       HexII compact binary representation
| pxf       show hexdump of current function
| pxh       show hexadecimal half-words dump (16bit
)
| pxH       same as above, but one per line
| pxl       display N lines (rows) of hexdump
| pxo       show octal dump
| pxq       show hexadecimal quad-words dump (64bit
)
| pxQ       same as above, but one per line
| pxr[j]    show words with references to flags and
 code
```

```
[0x004013d0 16% 320 /bin/true]> pxw @ entry0
0x004013d0  0x8949ed31 0x89485ed1 0xe48348e2 0x495
0x004013e0  0x4430c0c7 0xc7480040 0x4043c0c1 0xc7c
0x004013f0  0x00401330 0x5bf615ff 0x0ff40020 0x000
0x00401400  0x60721fb8 0x2d485500 0x00007218 0x0ef
0x00401410  0x76e58948 0x0000b81b 0x85480000 0x5d10
0x00401420  0x607218bf 0x66e0ff00 0x00841f0f 0x000
0x00401430  0x1f0fc35d 0x2e660040 0x00841f0f 0x000x
0x00401440  0x607218be 0x81485500 0x607218ee 0xfecp
0x00401450  0xe5894803 0x48f08948 0x483fe8c1 0xd14
0x00401460  0xb81574fe 0x00000000 0x74c08548 0x18b
0x00401470  0xff006072 0x001f0fe0 0x0f66c35d 0x000r
0x00401480  0x5dc13d80 0x75000020 0x89485511 0xff6
0x00401490  0xc65dffff 0x205dae05 0xc3f30100 0x004
0x004014a0  0x606e18bf 0x3f834800 0xeb057500 0x001.
0x004014b0  0x000000b8 0xc0854800 0x4855f174 0xd0f
0x004014c0  0xff7ae95d 0x2e66ffff 0x00841f0f 0x000
0x004014d0  0xba555441 0x00000005 0x4548be53 0xfb8
0x004014e0  0x8348ff31 0x8b4880c4 0x205d732d 0x8b4x
0x004014f0  0x00282504 0x89480000 0x31782444 0xfbfp
```

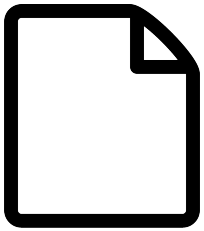


Chaum

Image source: Wikipedia

- David Chaum
- Blind signatures (1982)
- **E-Cash** (1983)
- Helped start the cypherpunk movement
- Digicash company (1989, first payment sent 1994, one US bank used for micropayments, defunct since 1998)

Mint



E-cash vs. Bitcoin

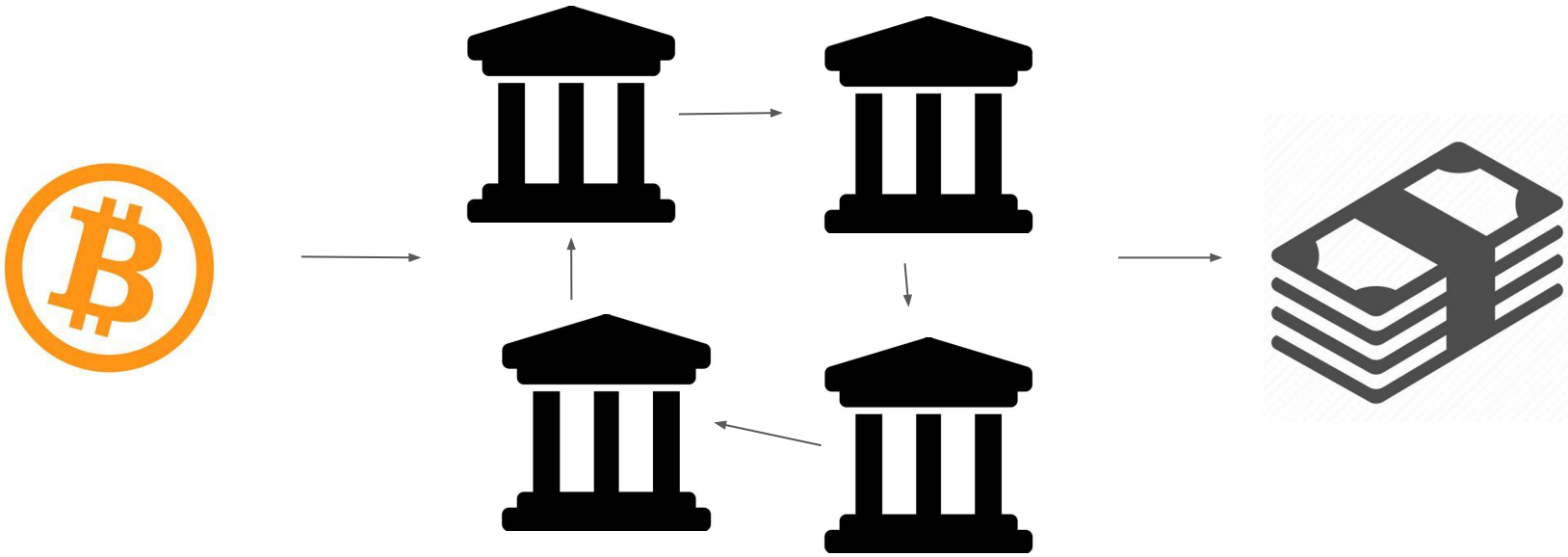
- Centralized
- Anonymous (due to blind signatures)
  - RSA with blinding factor that can be undone after signing
- Not UTXO or account based - you have actual “notes” - 100 sats, 200 sats etc. SCRIT calls it “digital bearer certificate”
- Different denominations = different signatures (since “bank” cannot see what it is signing)
- Double spending - you need to go to bank with your banknote and (anonymously) replace it with a new one

Idea

- Learn from history
- We don’t want to replace bitcoin - just make it easier to use
- With bitcoin you can have multisig -> replace centralized mint with “consortium”

- **Lightning: custodial vs. non-custodial wallet spectrum**
- Banknotes denominated in sats/bitcoin (but don’t need any blockchain!)
- Bad: it’s just a token (if consortium disappears notes are worthless)
- Easy “cashout” with lightning

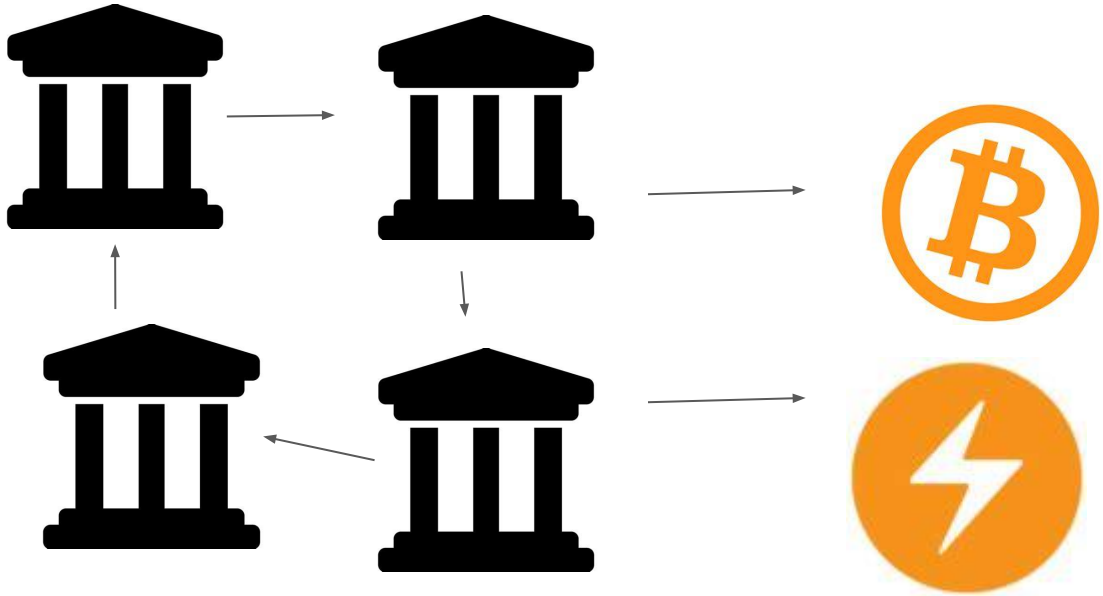
Schema



BFT

Usage

This is your non-custodial (lightning) wallet



BFT

Examples

- Fedimint.org resources
- SCRIT (2019 in Go) v1 and v2 - Jonathan Logan, Frank Braun
- OpenTransactions - multisig bitcoin
- **Minimint** (in Rust) from Eric Sirion
- Everything is alpha!

Questions

?