
jive5ab
The Swiss Army knife of (e-)VLBI
Harro Verkouter
jive
JOINT INSTITUTE FOR VLBI IN EUROPE

Archaelogy

```
$> cd ~/src/jive5ab
$> grep 'int main(' *cc
test.cc:int main(int argc, char** argv) {
```

Archaelogy

- aug 2007
  - 256Mbps e-VLBI w/ China demo’ed
  - severely hacked Haystack Mark5A software
  - StreamStor problems?
    - crashing, hanging, ...

StreamStor Real-
Contr

SI
U

XLRReadData

Syntax:

```
XLR_RETURN_CODE XLRReadData( SSHANDLE xlrDevice, PULONG Buffer,
ULONG AddrHigh, ULONG AddrLow, ULONG XferLength )
```

Description:

XLRReadData reads data from the StreamStor device. This function is identical to XLRRead without the structure to pass request parameters.

The address of the requested data must be an eight byte-aligned value.

If the StreamStor is in bank mode, this command will read data from the currently selected bank.

Parameters:

- `xlrDevice` is the device handle returned from a previous call to `XLROpen`.
- `Buffer` is the address of the user memory buffer to hold the requested data.
- `AddrHigh` is the upper 32 bits of a 64-bit byte address of the requested data.
- `AddrLow` is the lower 32 bits of a 64-bit byte address of the requested data.
- `XferLength` is the number of bytes requested.

Return Value:

On success, this function returns XLR_SUCCESS.
On failure, this function returns XLR_FAIL.

Usage:

```
SSHANDLE        xlrDevice;
XLR_RETURN_CODE xlrReturnCode;
ULONG           myBuffer[ 40000];

xlrReturnCode = XLROpen( 1, &xlrDevice );

//AddrHigh and AddrLow must represent an appropriately aligned address.
xlrReturnCode = XLRReadData( xlrDevice, myBuffer, 0, 0xFE120000,
sizeof(myBuffer) );
```

See Also:

XLRRead, XLRSetMode, XLRSetDBMode, XLRSetBankMode and XLRSelectBank.

test program ‘test.cc’

- read data from StreamStor
  ≤ 1 day
- implement prot
  ≤ 1 a we
- slowed a bit
  still ...

We may be on to something!

test program ‘test.cc’

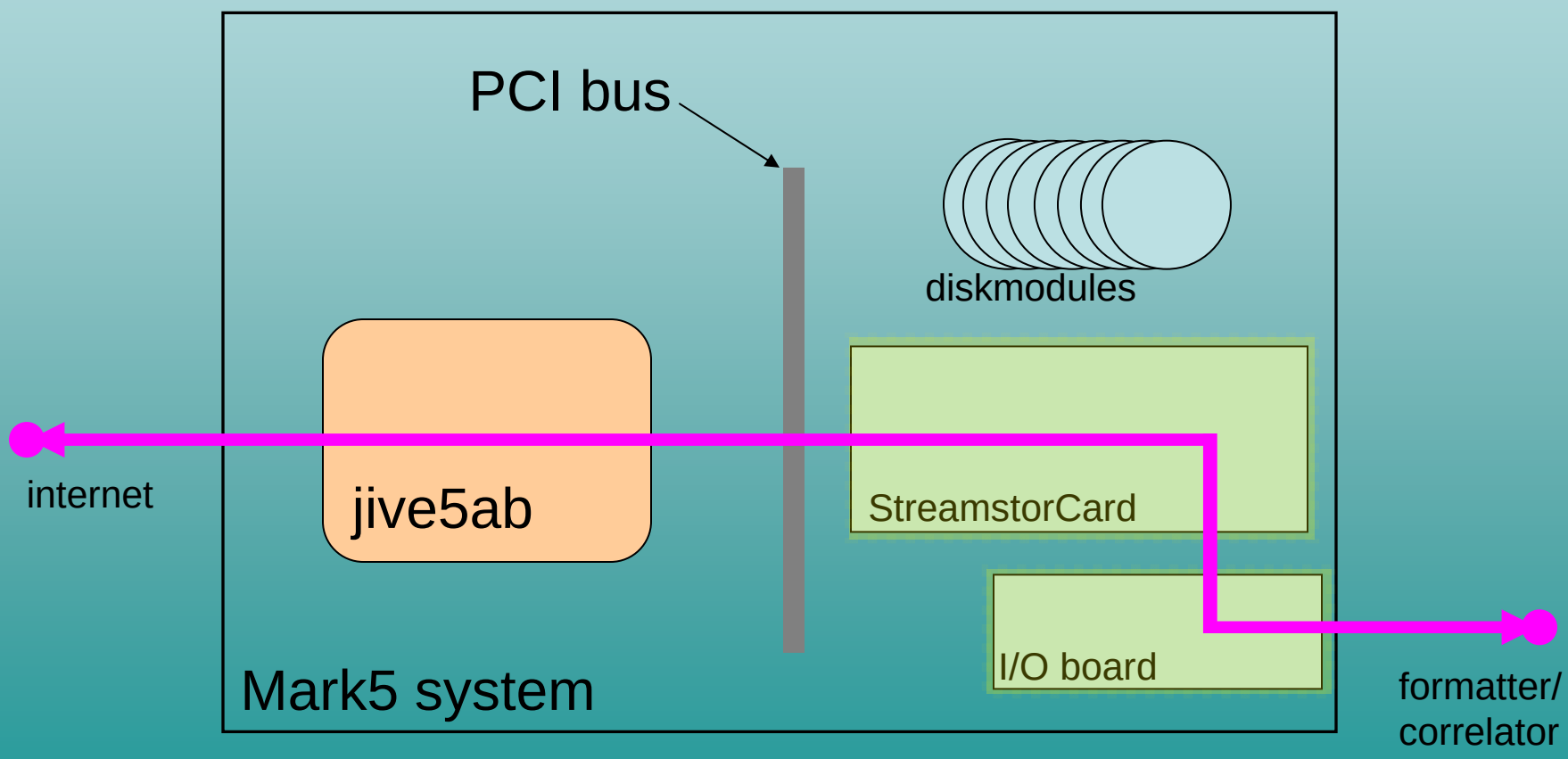
- add remote command interface
  - internal command execution system

    still in use today
- implement VSI/S style commands; in 2012:
  - Mark5A command set v. 2.73
  - Mark5B command set v. 1.12
  - jive5ab specific

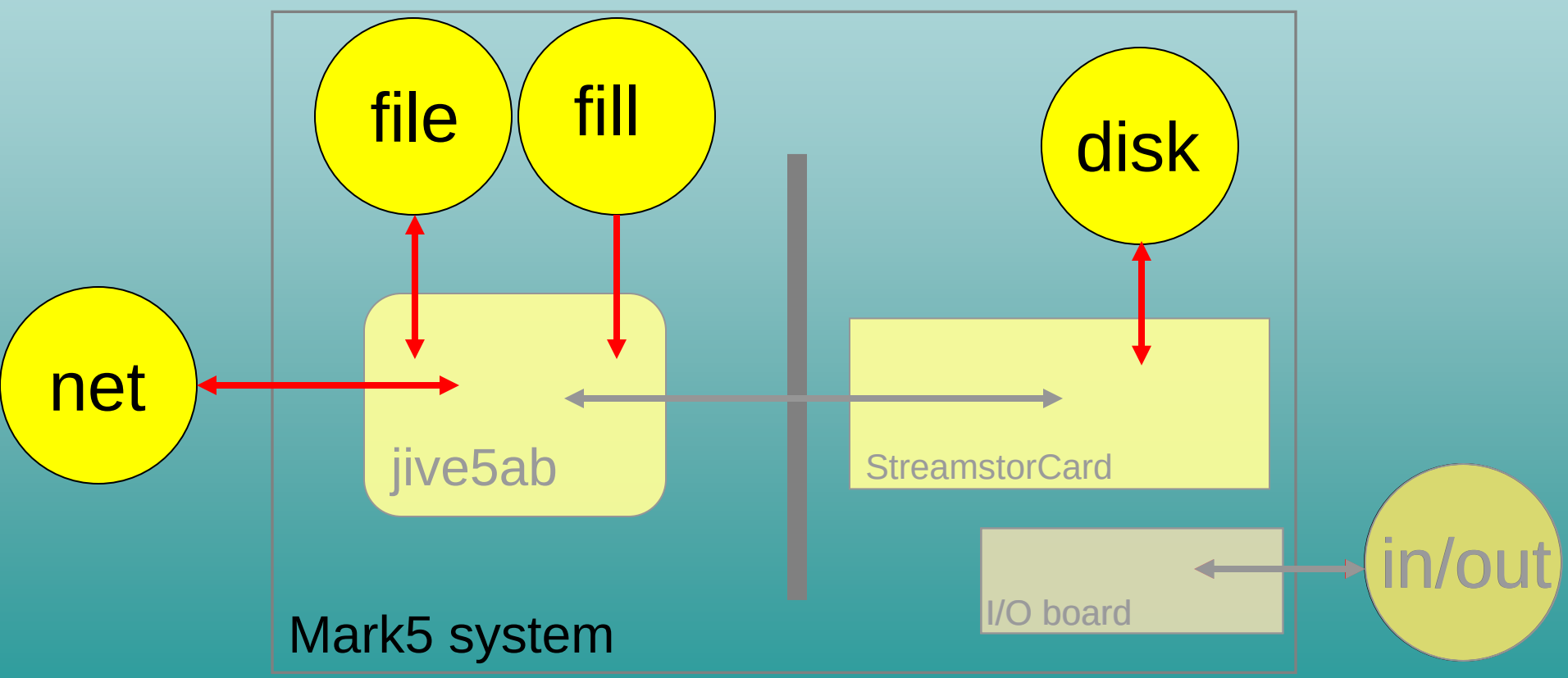
Supported platforms in 2012

- Mark5A, B and partially C
- Intel CPU based
  - GNU c++ compiler
  - POSIX compliant O/S
    - Linux
      - Debian, RedHat, Gentoo
    - Mac OSX
- 32 and 64 bit
  - all platforms
  - not on Mark5 if StreamStor support needed

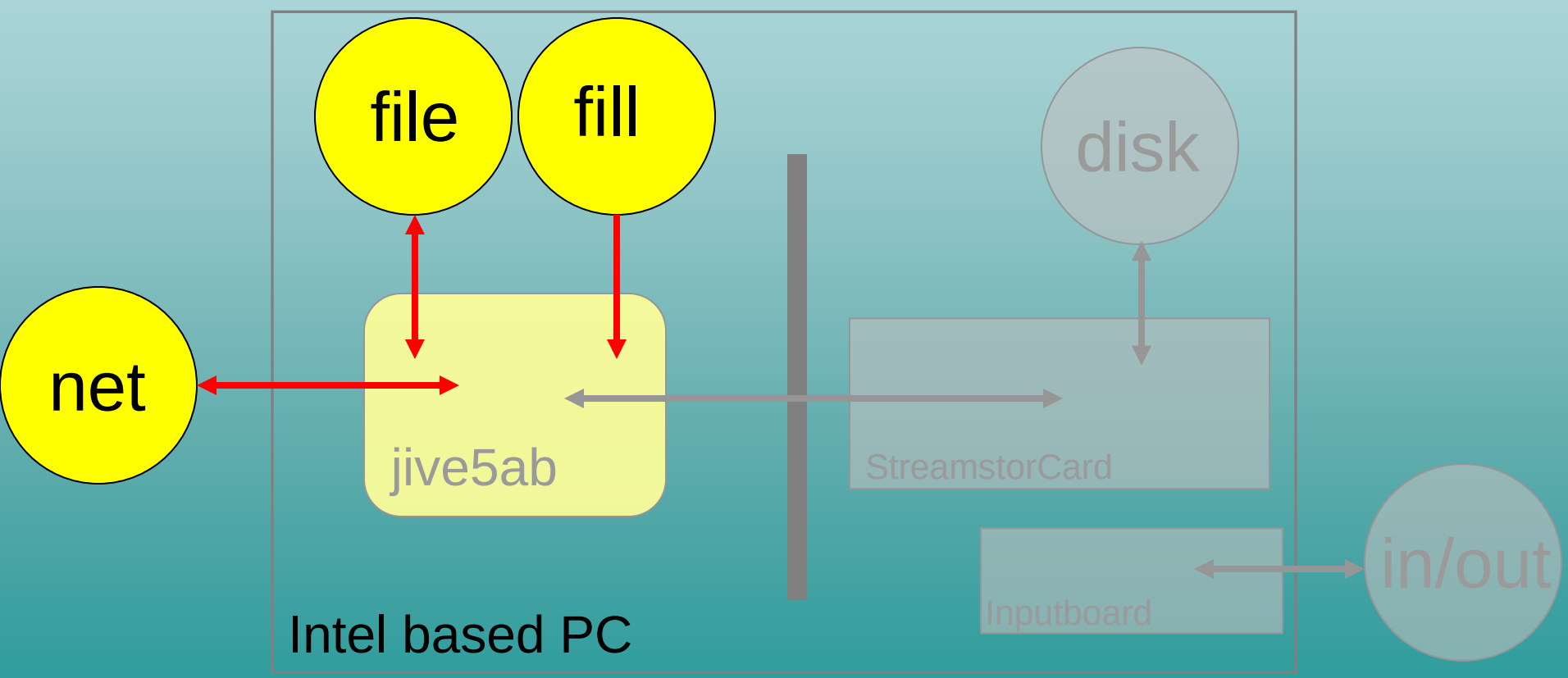
Dataflow e-VLBI



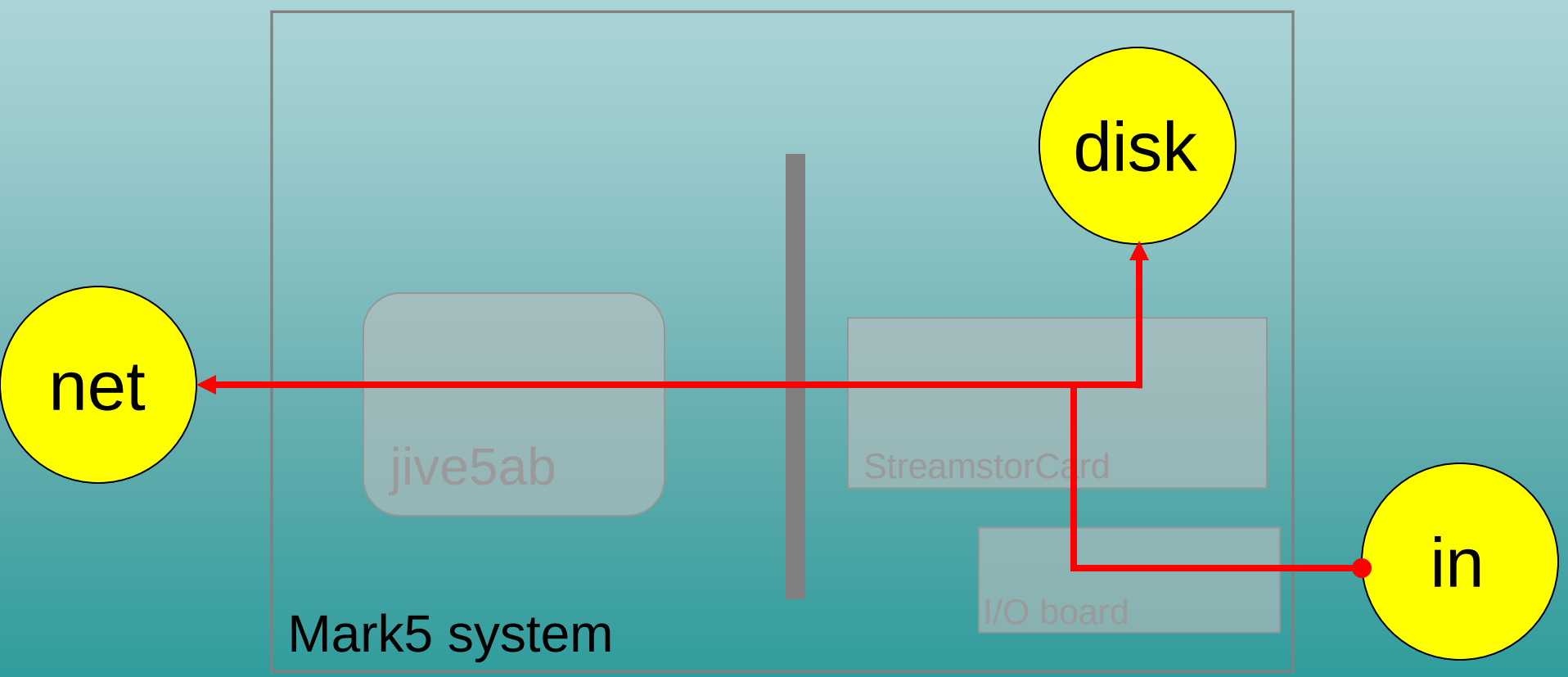
VLBI connectivity: ***src2dst***



VLBI connectivity: ***src2dst***

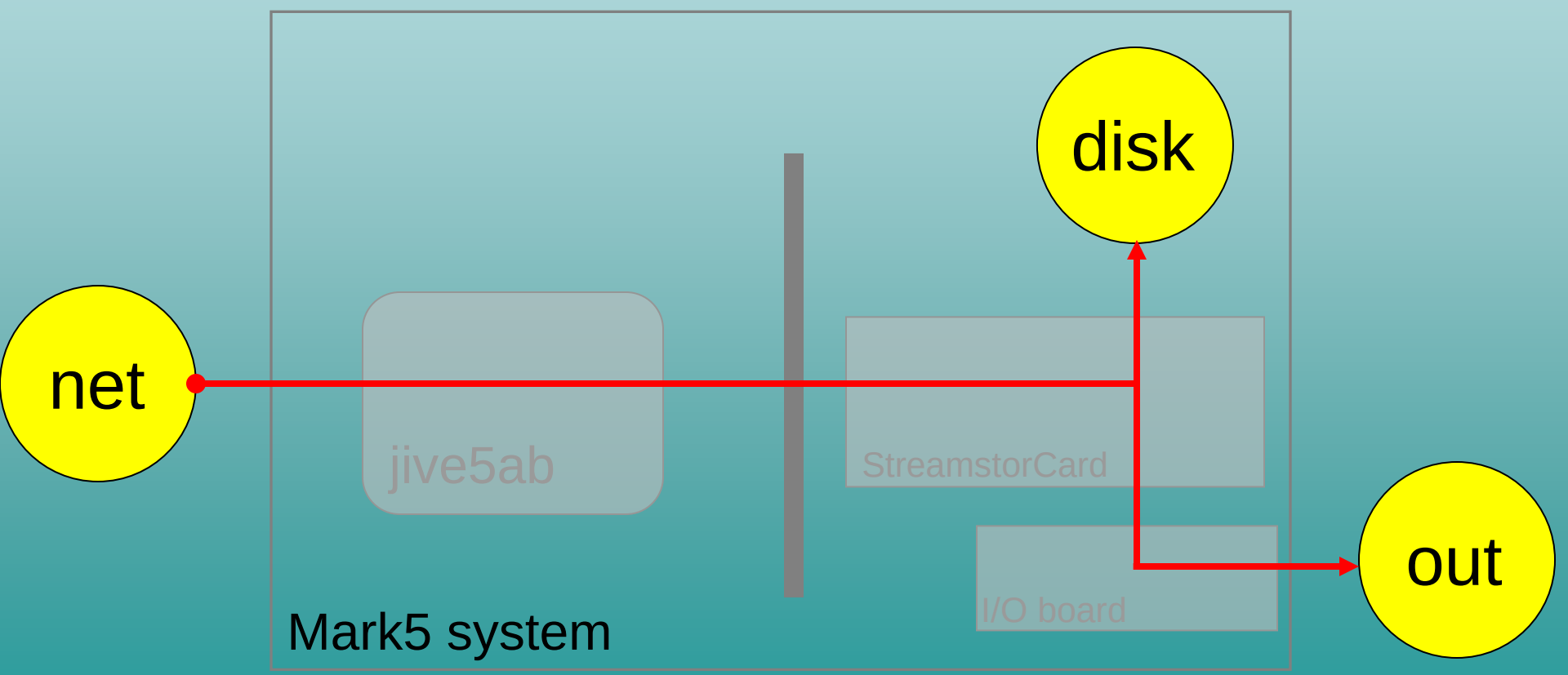


VLBI connectivity: *src2dsts (p.)*



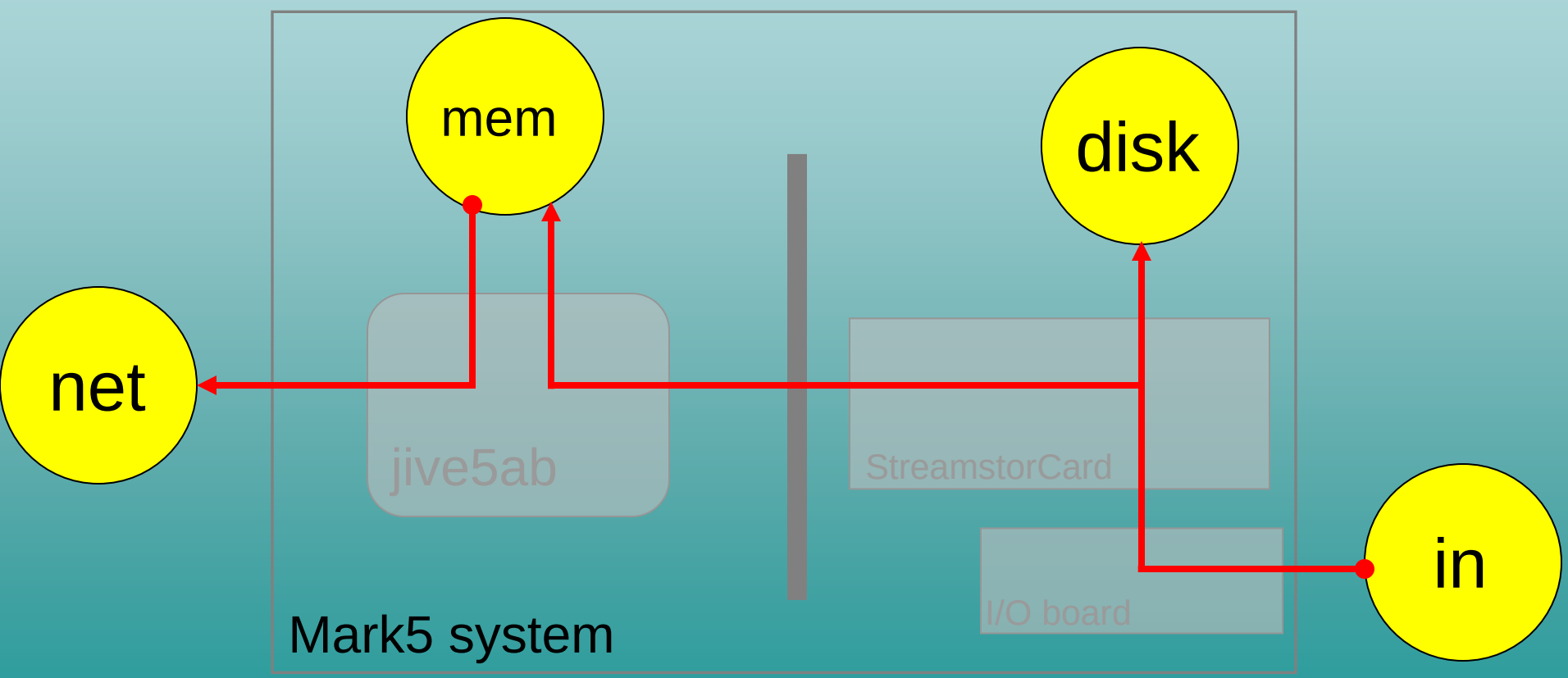
real-time sending + recording @ station

VLBI connectivity: *src2dsts (p.)*



real-time reception + recording @ correlator

VLBI connectivity: *src2dsts (p.)*



future e-VLBI: always recording, 2nd transfer on demand

VLBI connectivity:

- disk2net, disk2out, disk2file,
- in2net, in2disk, in2fork, in2file
- net2out, net2disk, net2file, net2check, net2sfxc,
- fill2net, fill2file, fill2out
- spill2net, spid2net, spin2net, spin2file, splet2net, splet2file
- spill2file, spid2file, spif2file, spif2net
- file2check, file2mem
- in2mem, in2memfork, mem2net

Supported network protocols

“*net_protocol=...*”	Description
udp	*mtu* sized packets with 64 bit sequence number. receiver can compensate reordering/loss (VTP)
pudp	plain *mtu* sized udp packets, NO sequence numbers. can be used on reliable (local) links
tcp	standard tcp
rtcp	‘reverse’ tcp, reverses **connection** direction between sender/receiver for firewalled receivers. data direction unchanged.
unix	unix socket on local machine

Built-in network statistics

- RFC4737 compliant (cvs head)
- “evlbi?”
  - packet loss
  - packet reordering
  - extent of reordering
- “evlbi = <*formatstring*>”
  - “%l” amount of packets lost, “%L” loss as %
  - “%u” unix timestamp, “%U” human readable
  - “%o” amount of out-of-order packets, “%O” as %
  - few more

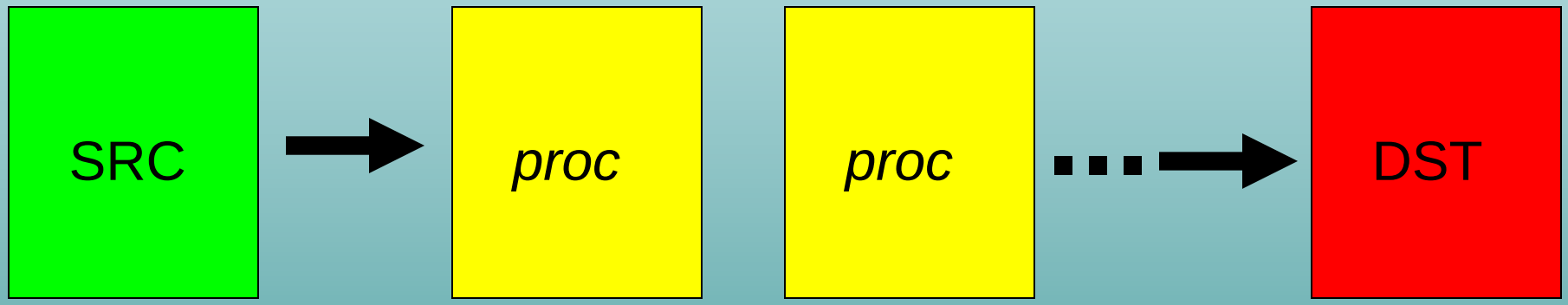
Supported dataformats

- Mark4
- VLBA
- Mark5B
  - up to 4096Mbps!
- VDIF
  - including legacy
- none
  - allows anonymous transfer of data
    - set “mode = none”

Data processing - 2010/2011

- significantly improved data processing core
- programmatically build processing chains
  - decide at runtime wether to include steps
  - each step runs in own thread
  - data passed via ‘work’ queue
- build collection of simple steps
  - enormous re-use of steps - mix ‘n match to taste!
- allows easy
  - experimentation with variations
  - addition of completely new steps

Data processing - 2010/2011



network
formatter
file
...

compression
filtering
debug
...

correlator
diskmodule
file
network
...

```
// The hardware has been configured, now start building the processing chain
chain   c;

if( toqueue ) {
    c.add(&fifo_queue_writer, 1, queue_writer_args(&rte));
} else {
    c.add(&fiforeader, 10, fiforeaderargs(&rte));

    // If compression requested then insert that step now
    if( rte.solution ) {
            DEBUG(0, "in2net: enabling compressor " << dataformat << endl);
            if( dataformat.valid() ) {
                    c.add(&framer<frame>, 10, framerargs(dataformat, &rte));
                    c.add(&framecompressor, 10, compressorargs(&rte));
            } else {
                    c.add(&blockcompressor, 10, &rte);
            }
    }
    // Write to file or to network
    if( tofile ) {
            c.add(&fdwriter<block>, &open_file, filename, &rte);
    } else  {
            c.add(&netwriter<block>, &net_client, networkargs(&rte));
    }
}
// set everything running
c.run();
```

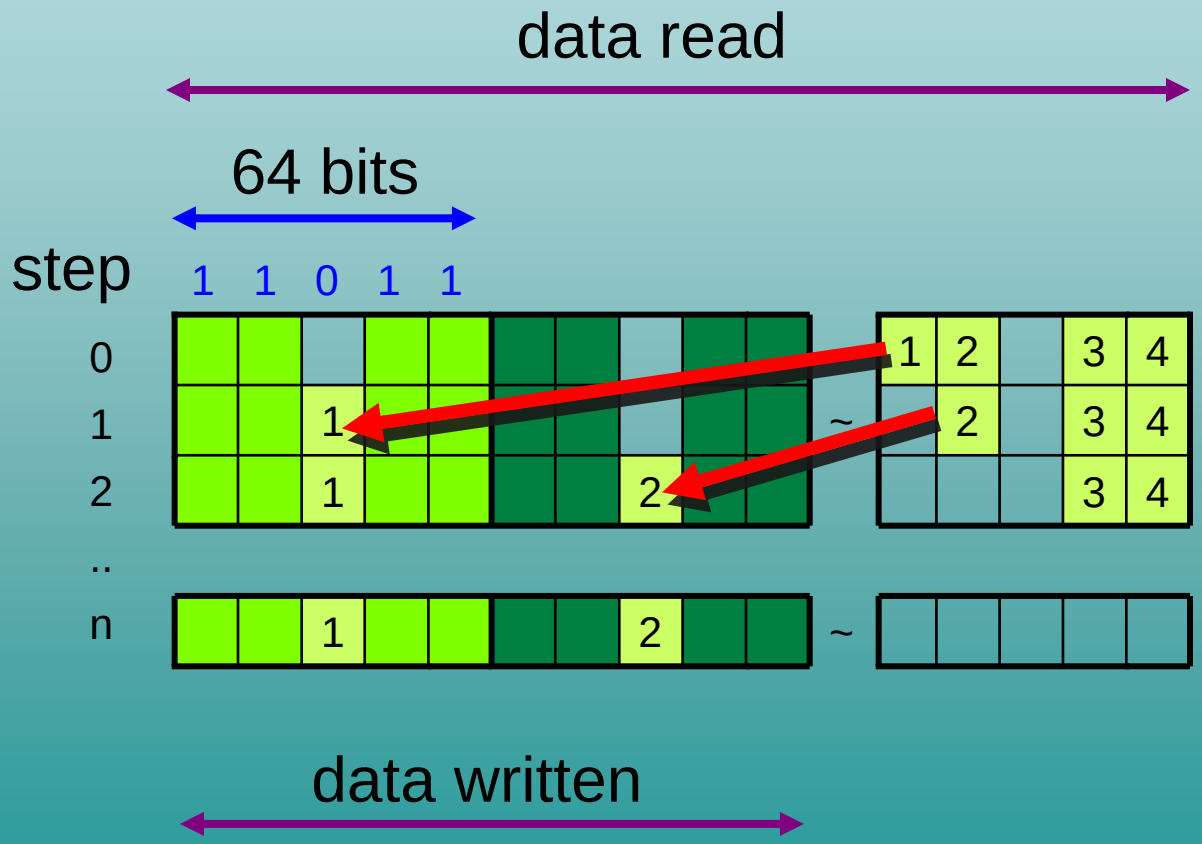
```
if( toqueue ) {

} else {


    // If compression requested then insert that step now
    if( rte.solution ) {

            if( dataformat.valid() ) {


            } else {

            }
    }
    // Write to file or to network
    if( tofile ) {

    } else  {

    }
}
```

```
chain   c;

if( toqueue ) {
    c.add    fifo_queue_writer
} else {
    c.add    fiforeader


    if( rte.solution ) {

            if( dataformat.valid() ) {
                    c.add    framer
                    c.add    framecompressor
            } else {
                    c.add    blockcompressor
            }
    }

    if( tofile ) {
            c.add    fdwriter
    } else  {
            c.add    netwriter
    }
}

c.run();
```

Built-in performance statistics

- “tstat?”
  - human readable
    - time elapsed since last call
    - name of the thread
    - amount of bytes/s processed by each thread since then
  - global ‘time of last call’
    - problems if > 1 users polling
- “tstat=“
  - machine readable
    - unix timestamp
    - name of the thread
    - raw bytecounts for each thread

Feature: data compression



Feature: data compression

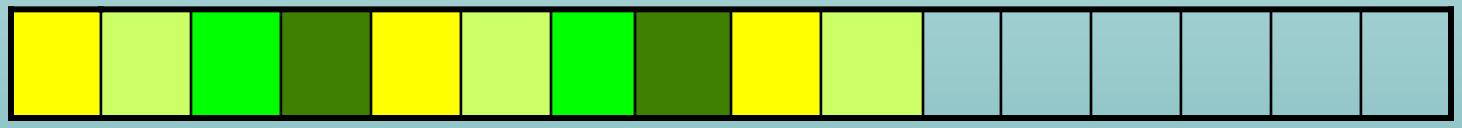
- used to bring down output bandwidth
  - 1024Mbps observing > 1Gbps network link
- ‘channel dropping’
  - allows user to select which bitstream(s) can be dropped
  - unused bits will be overwritten by used bits
- just-in-time compression/decompression routine
  - code generated, compiled + linked by jive5ab using system gcc
  - dynamically loaded back into jive5ab
- use “trackmask=0x....” to enable
  - max 64 bit; default bit is ‘0’ if less than 64 bits specified
  - “trackmask = 0” disables the feature

Feature: debug + testing

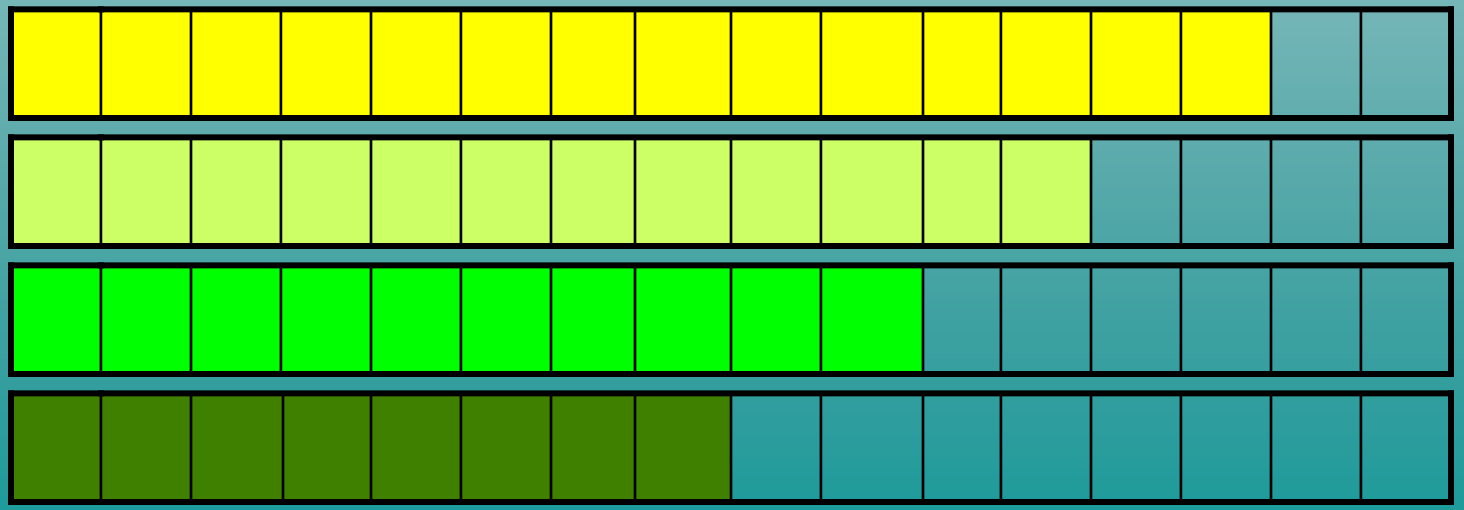
- in2file
- file2check
  - print all timestamps in file
- net2check
  - print timestamp if integer second changes
- fill2[net|file|out]
  - generate frames as per set data format
    - syncword
    - timestamp
    - fixed or incrementing pattern (fixed = increment 0 ...)
  - honours compression “trackmask=“

Feature: cornerturning (2012)

input: one buffer with N channels



output: N buffers with one channel each



Feature: cornerturning (2012)

- input
  - packed data format, carrying N channels
    - Mark4, VLBA, Mark5B, multi channel VDIF
  - from *any* input!
- output
  - single channel, multi thread VDIF
  - multi channel, multi thread VDIF
  - threads individually routable
    - different files OR different network destinations
    - including ‘nowhere’
    - not yet mixed
  - output VDIF framesize can be != input frame size
    - allows reframing in multiples of input channel size

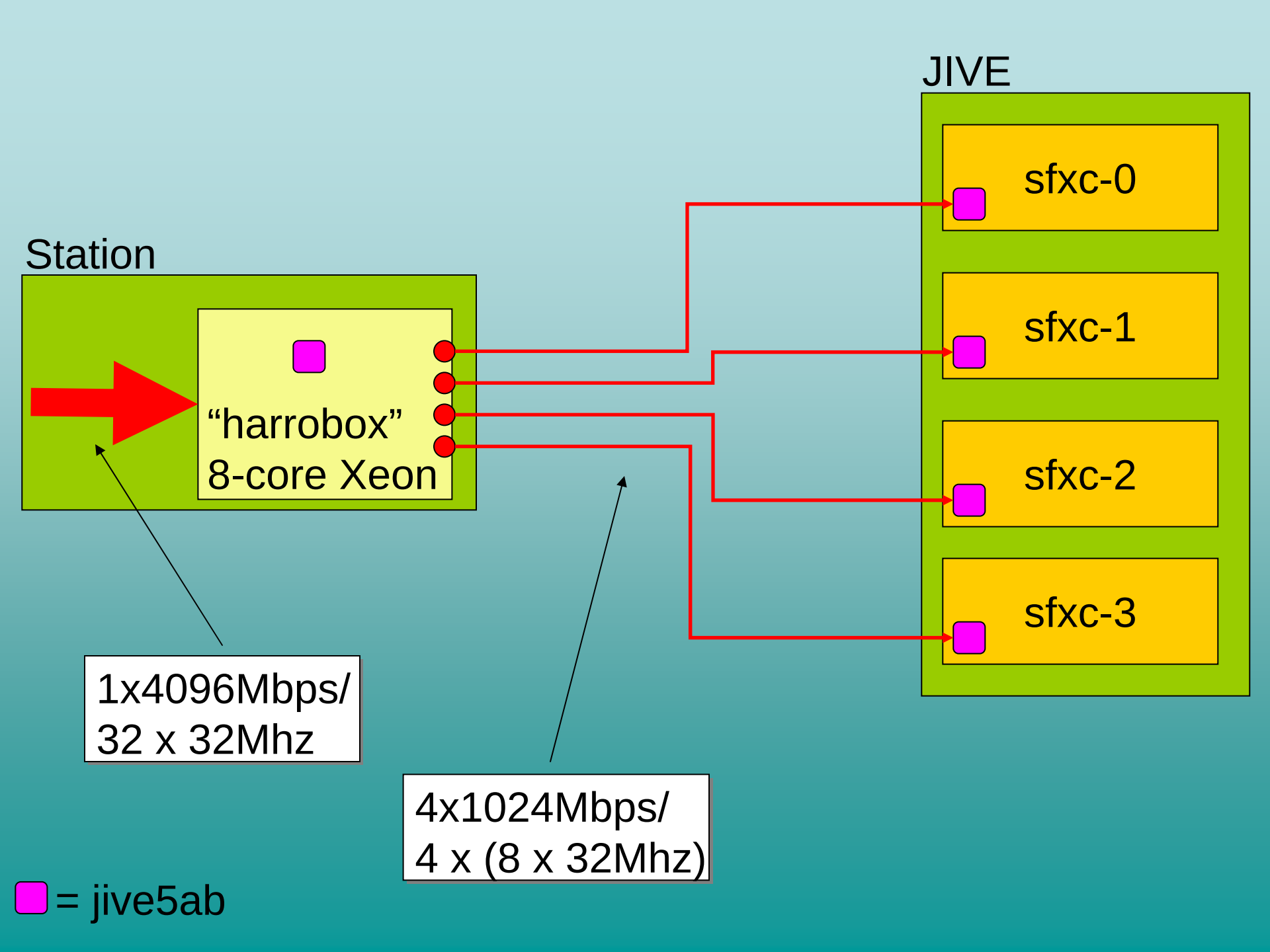
Feature: cornerturning (2012)

- hand crafted Intel SSE2 SIMD assembler code
  - for specific formats
    - Mark4/VLBA 4/8 channel fanout-2 (512Mbps)
    - 8 channel Mark5B (512Mbps)
  - breaking data up
    - 4x8bit, 2x16bit, 4x16bit, 2x32bit
  - swapping Mark5B sign-mag bits
    - VDIF and Mark5B have opposite ‘endiannes’
- dynamic channel extractor
  - relatively slow, just-in-time code generation + loading
  - “`32>[0,3][13,19]....`”
    - from each 32 bits
      - extract bits 0, 3 into channel 0
      - extract bits 13, 19 into channel 1
  - accomodate any format

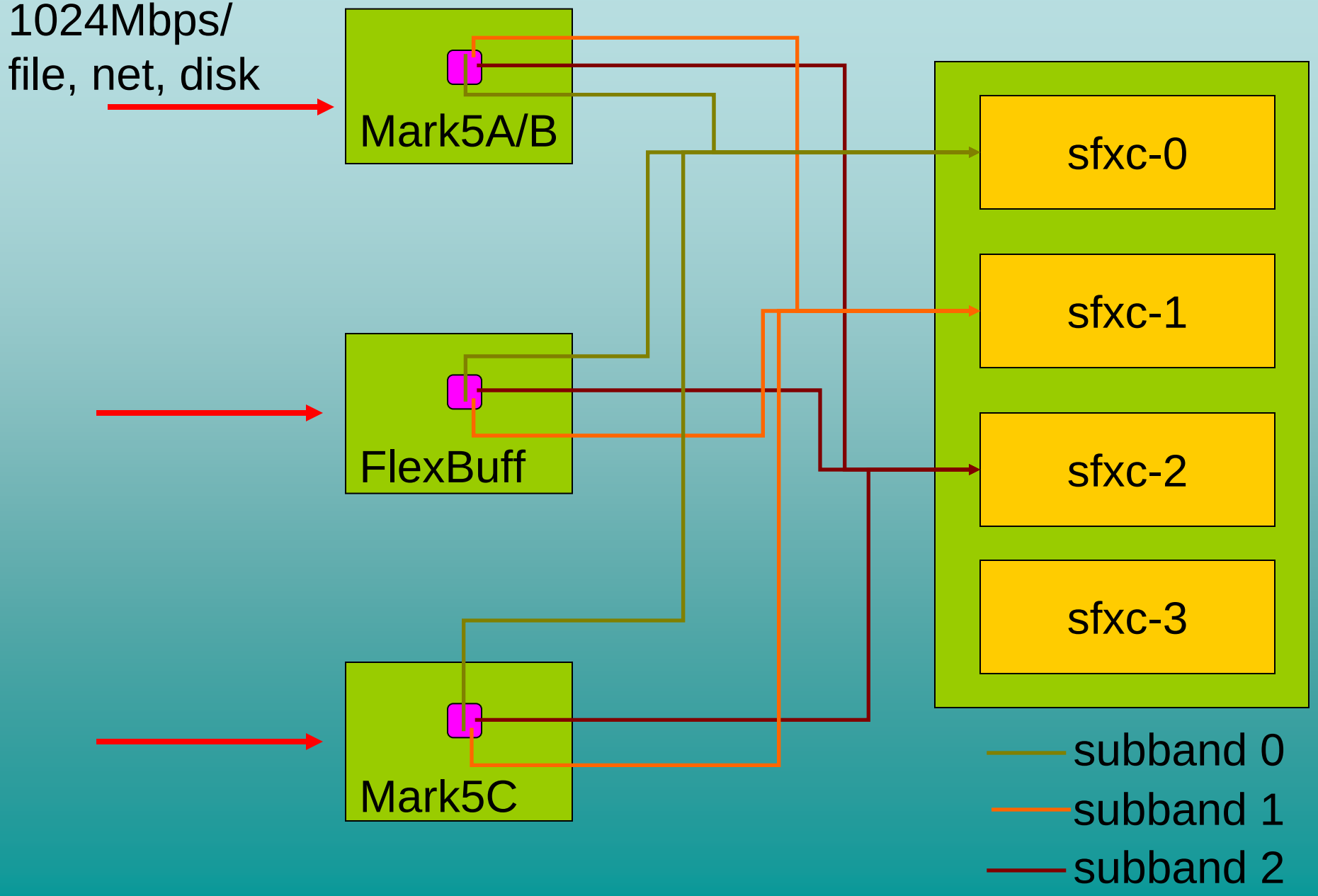
Feature: cornerturning (2012)

Splitting/cornerturning can be daisy-chained

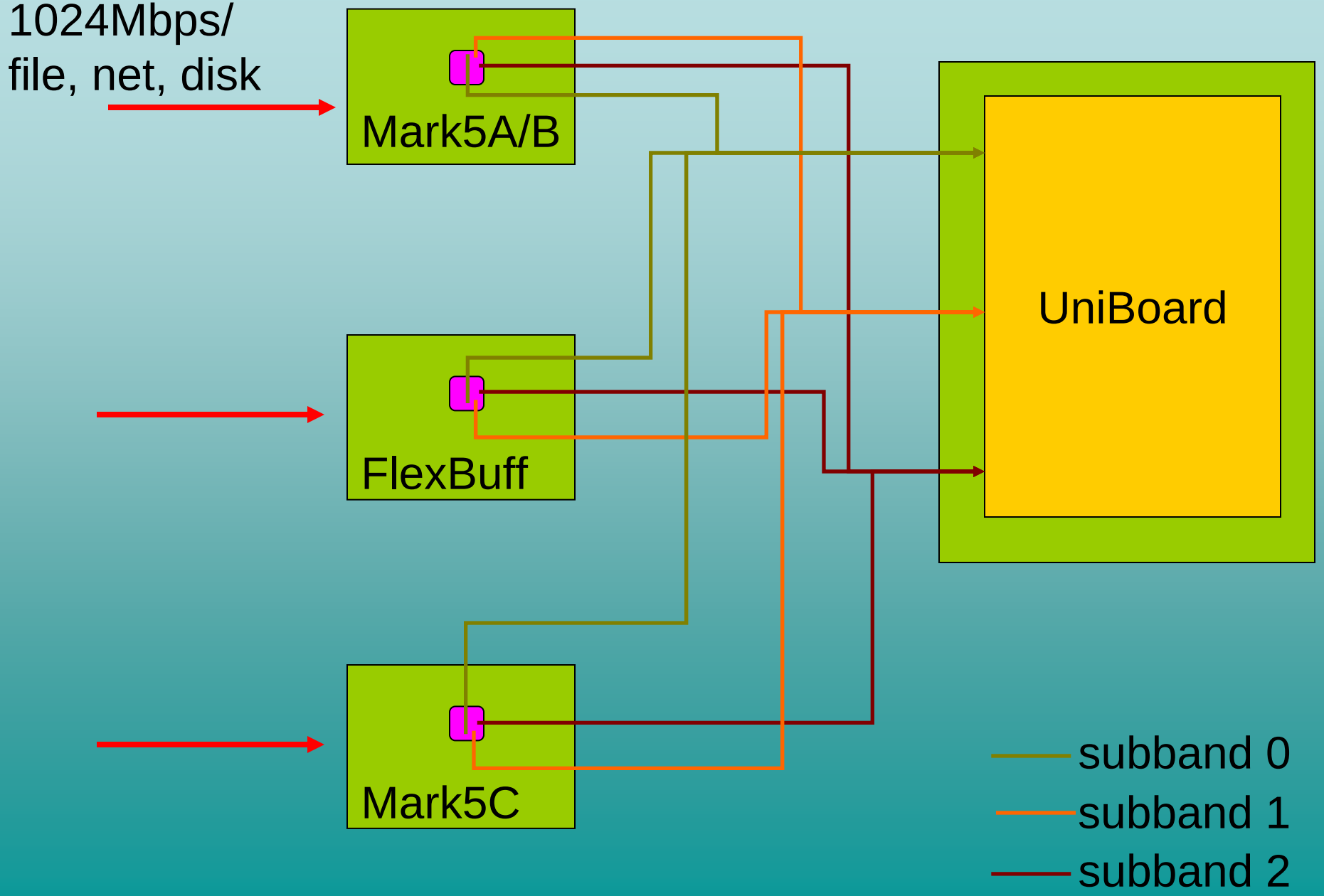
- 1024Mbps Mk4 = 16 channel obs = 2 x 8 channel Mk4 layout
  - split into 2x32bit
  - use 8 channel Mk4 cornerturner on both parts
- 4096Mbps = 32 channel Mk5B obs = 4 x 8 channel Mk5B layout
  - split into 4x16bit
  - use 8 channel Mk5B cornerturner on each of the four parts
- the dynamic channel extractor can be part of it too


JIVE
sfxc-0
sfxc-1
sfxc-2
sfxc-3
Station
“harrobox”
8-core Xeon
1x4096Mbps/
32 x 32Mhz
4x1024Mbps/
4 x (8 x 32Mhz)
= jive5ab

JIVE


1024Mbps/
file, net, disk
Mark5A/B
FlexBuff
Mark5C
sfxc-0
sfxc-1
sfxc-2
sfxc-3
subband 0
subband 1
subband 2

JIVE


1024Mbps/
file, net, disk
Mark5A/B
FlexBuff
Mark5C
UniBoard
subband 0
subband 1
subband 2

Bugs

- No documentation
- No documentation
- No documentation
- parameter space is huge
  - chance of combinations which will #FAIL
- there's always verkouter@jive.nl ...

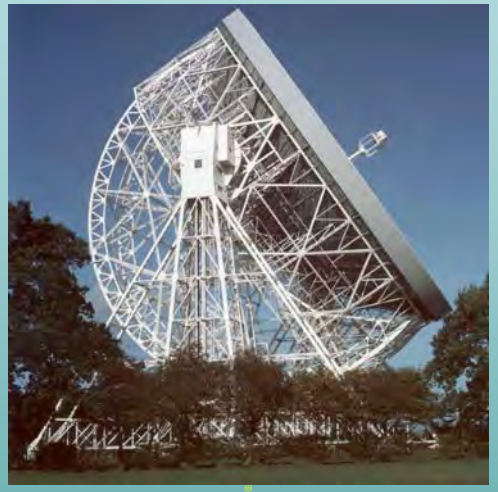
Thanks for your attention!

QuickTime™ and a
decompressor
are needed to see this picture.

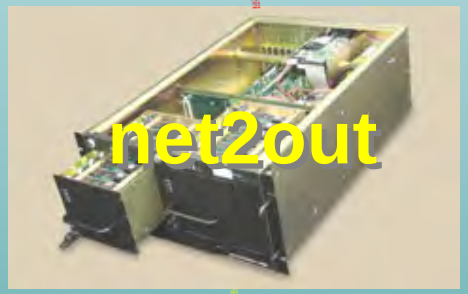
Primary objective

internet

Primary objective



internet



Packet size + spacing for UDP

- “mtu = <number>” (bytes)
  - jive5ab computes max payload
    - depending on format and boundary conditions
  - resize internal buffers to integral #-of-packets
  - default is 1500
- “ipd = <number>” (microseconds)
  - packet spacing absolutely necessary for UDP
  - timing of next packet is wall-clock time based
    - not relative or ‘roughly that time’

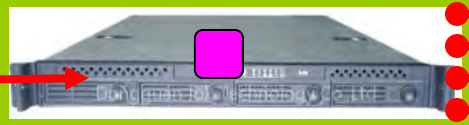
= jive5ab

Station

Mark5C

1x4096Mbps

FiLa10G



harrobox

JIVE

sfxc-0

sfxc-1

sfxc-2

sfxc-3

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    }
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