SMA Real-time Software

Attila Kovács
SAO

SMA Advisory Committee Meeting
Cambridge, 17–18 July 2018

Objectives

1. Maintain
2. Fix
3. Improve
4. Enhance

Overview: Architecture

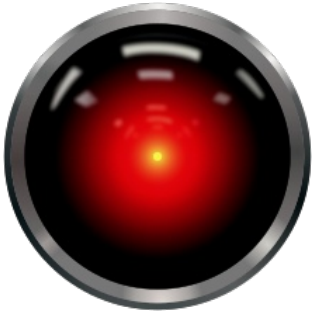
engdb

m5

acc1

...

acc8



hal9000

obscon

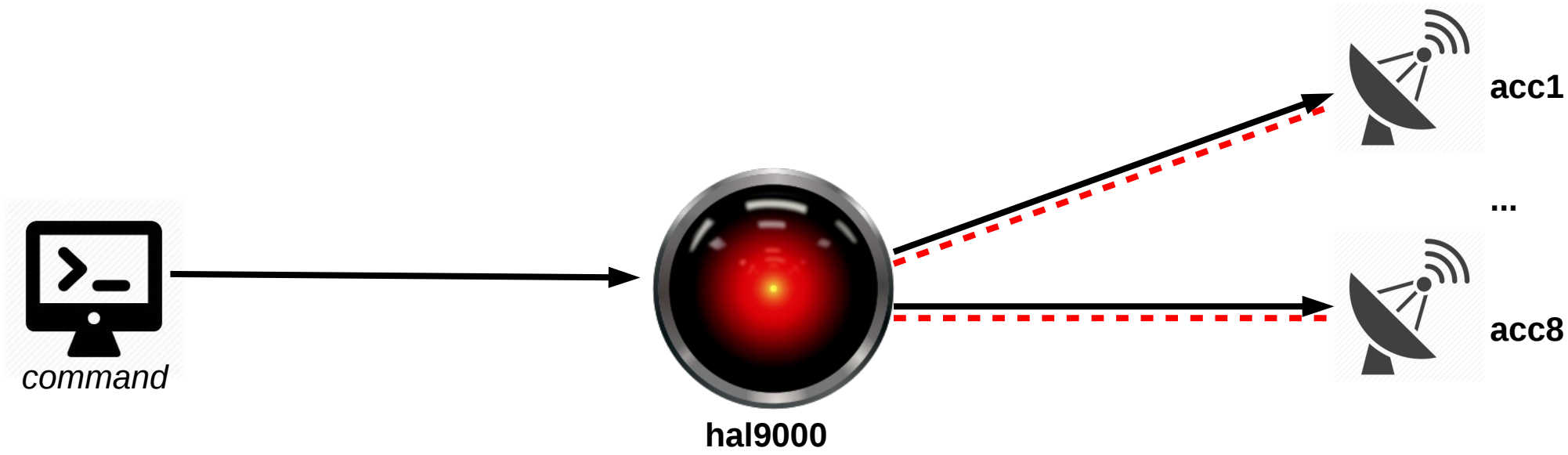
newdds

hcn

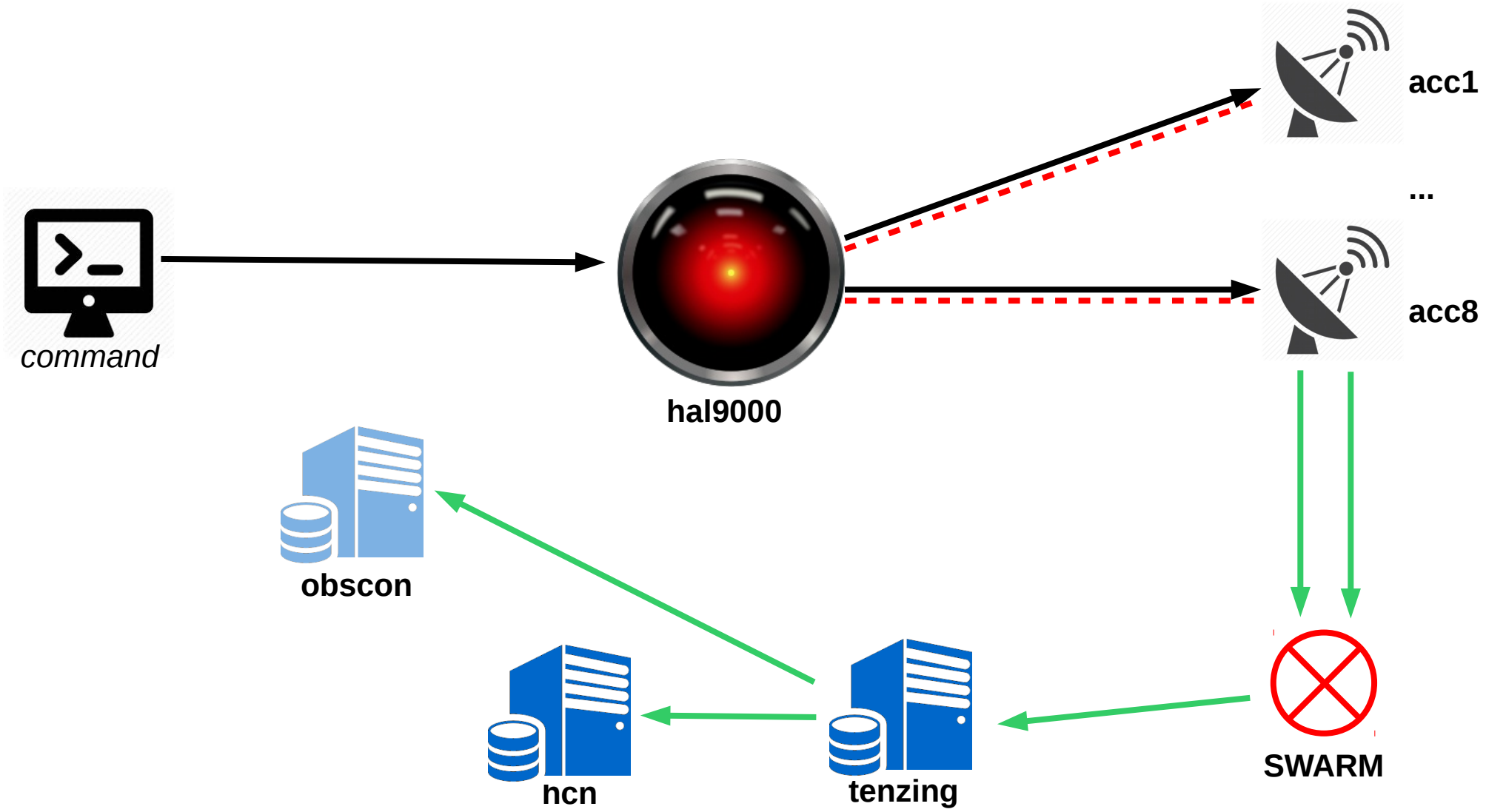
tenzing

SWARM

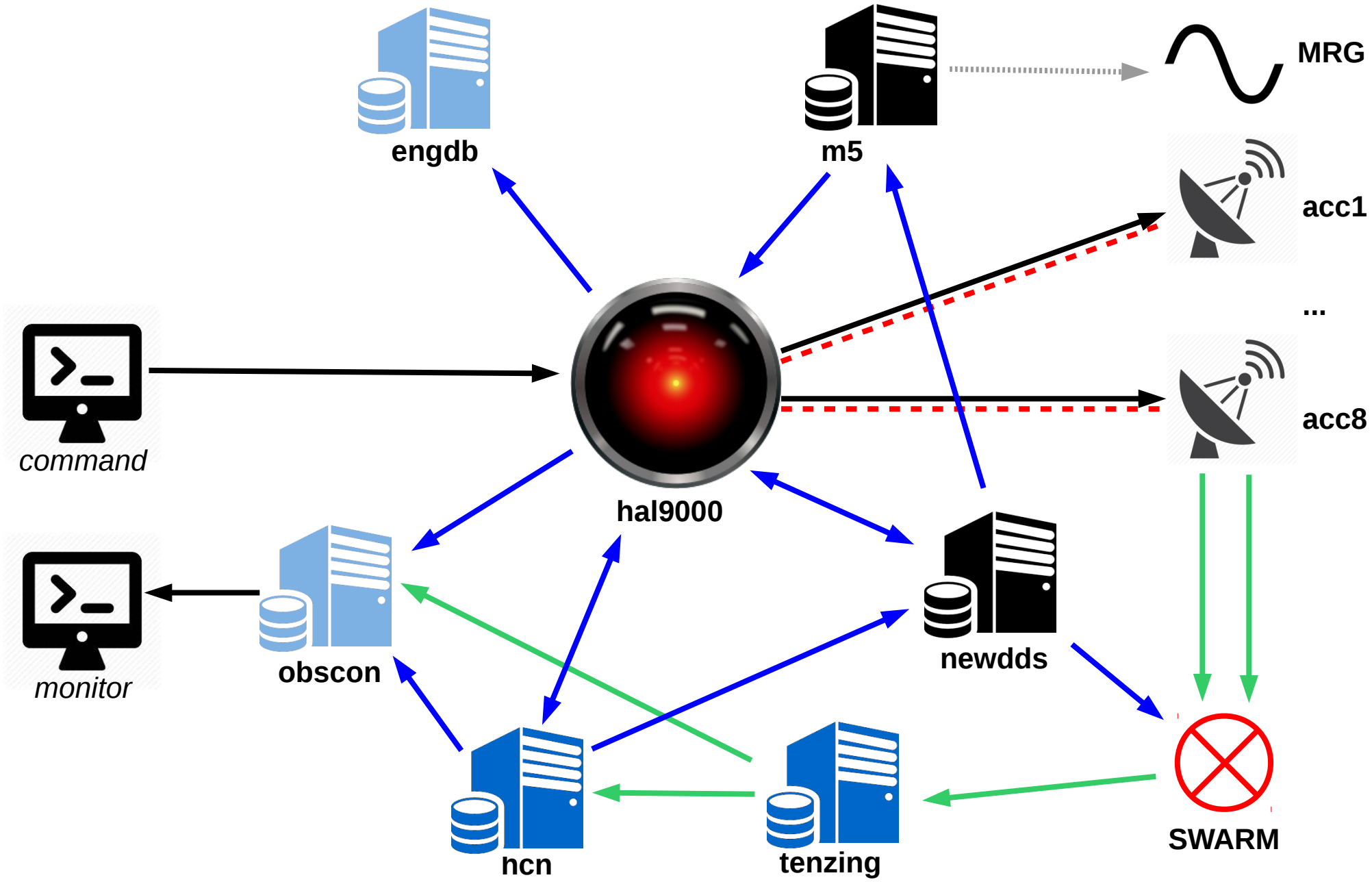
Overview: Architecture - 2



Overview: Architecture - 3



Overview: Architecture - 4



Overview: Stats

Language	LynxOS	Linux	all
C	**264k**	73k	365k
b[a]sh	3.7k	16k	18k
perl	7.8k	4.2k	13k
[t]csh	4.3k	-	10k
python	-	2.6k	**2.6k**
other	15k	2k	20k
all	295k	98k	**429k**

Real-time Software Team

Thomas Mac Cooper

Paul Grimes

Ryan Howie

Garrett ‘Karto’ Keating

Attila Kovács

Scott Paine

Nimesh Patel

Ram Rampasao

Taco

Bob Wilson

Maintain

Keep the SMA fully operational as computers and hardware components get replaced, and as OS and 3rd-party software are updated.

Maintain: git version control

CVS → git in Fall 2017

- **up-to-date code base**
- **includes runtime configurations files**
- **in-tree builds**
- **better cross-referencing**

Maintain: git version control

Smithsonian / **SMA-Software**

Unwatch 14 | Unstar 2 | Fork 1

Code | Issues 0 | Pull requests 0 | Projects 0 | Wiki | Insights

smashLogExtract: Increased max data file SMAsh log to 2000 -> 5000 li…

Browse files

…nes, as some data files had logs getting too close to old limit.

master

attipaci committed 5 days ago 1 parent dad02d2 commit 5be40c932c73c604ccbaba181c5426d5bca74c0b

Showing **1 changed file** with **2 additions** and **2 deletions**.

Unified | Split

4 online/LynxOS/applications/hal/utilities/smashLogExtract.pl View

```
@@ -6,8 +6,8 @@
 # This script is run by endProject but can be run by itself as well.

 # first create a shorter smashlog file since the original file
-# might be too huge. Just extracting last 2000 lines into a temp file
-$response=`tail -2000 /rootfs/logs/SMAshLog > tSMAshLog`;
+# might be too huge. Just extracting last 5000 lines into a temp file
+$response=`tail -5000 /rootfs/logs/SMAshLog > tSMAshLog`;
 if($response ne "") { die "$response\n";}

 # opening this tempfile and reading in all the lines
```

0 comments on commit 5be40c9

Lock conversation

Maintain: LynxOS

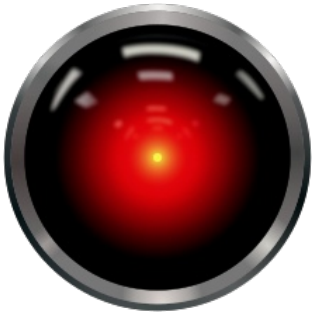

engdb


m5


acc1

...


acc8


hal9000


obscon


newdds


hcn

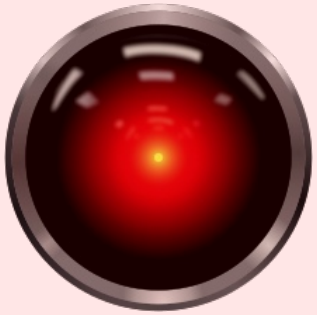

tenzing


SWARM

Maintain: LynxOS

PowerPC / LynxOS

...



Maintain: LynxOS → Linux

- **Affects a lot of computers & code**
- **LynxOS vs. Linux differences, peculiarities, kludges**
- **PowerPC hardware** (e.g. reflective memory, timing, servos)

Maintain: LynxOS → Linux

- **hal9000 (2018)**
  - PowerPC/LynxOS → Linux/x86_64 VM.
  - reflective memory → global redis database with quasi-equivalent API (sma-rm)
  - timing-hardware → ntp
  - test with hangar antenna first
  - array deployment by end of 2018…
- **acc1 – acc8 (2019?)**

Maintain: Documentation

inline

git / markdown

wiki

operations log

Maintain: Documentation (inline)

```
/**
 * Converts horizontal (AZ/EL) coordinates to equatorial (RA/DEC) coordinates, for a given site,
 * and at a given Local Sidereal Time (LST).
 *
 * \param ho                    Pointer to the horizontal coordinates (in radians).
 * \param lstAngle              (radian) Local Sidereal Time as angle
 * \param latitude              (radian) Geodetic latitude of observer.
 * \param eq                    (radian) Pointer to the returned equatorial coordinates.
 *
 */
void horizontalToEquatorial(const HorizontalCoordinates *ho, double lstAngle, double latitude, EquatorialCoordinates *eq) {
  double sinaz, cosaz, sinel, cosel, sinphi, cosphi, sinh, cosh;
  double X;

  sincos(ho->az, &sinaz, &cosaz);
  sincos(latitude, &sinphi, &cosphi);                // geodetic latitude
  sincos(ho->el, &sinel, &cosel);

  // Prevent asin issues due to floating-point precision...
  X = sinel * sinphi + cosel * cosphi * cosaz;
  if(X < -1.0) X = -1.0;
  else if(X > 1.0) X = 1.0;

  eq->dec = asin(X);
  eq->cosDEC = cos(eq->dec);
  sinh = -sinaz * cosel;
  cosh = sinel * cosphi - cosel * sinphi * cosaz;

  eq->ra = lstAngle - atan2(sinh, cosh);

  if(eq->ra < 0.0) eq->ra += TWOPI;
}
```

Maintain: Documentation (git / markdown)

To enable/disable pipelining, you can simply call the `setPipelinedRM()` function with a `boolean` argument *BEFORE* `rm_open()`. E.g. to enable pipelined writes:

```
setPipelinedRM(TRUE);
...
rm_open(antlist);
```

Pipelined mode is *enabled* by default.

3.2. Efficient pipelined (bulk) reads

It is possible to use pipelined request for reading too with higher throughput, when pipelined modes is enabled, by enclosing `rm_read()` calls within `rm_start_bulk_reads()` and `rm_end_bulk_reads()` statements, e.g.

```
#include <redisrm.h>

/* ... */

  int readTimeoutMillis = 1000;
  int status;

  setPipelinedRM(TRUE);

  rm_open(&antlist);

  rm_start_bulk_reads();

  rm_read(ant1, "RM_AZOFF_D", &azoff);
  rm_read(ant1, "RM_ELOFF_D, &eloff);
  /* ... */
```

Maintain: Documentation (wiki)

SMA OBSERVER CENTER

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Welcome akovacs

SMA Wiki

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All pages

Click a column header to sort

name	modified (UTC)	modified by	tags
Second Shift Troubleshooting document	2018-07-16 12:50	rhowie	observations:operations, troubleshooting
Vacuum Pump is Automated with autoVacuumPump	2018-07-14 20:19	rrao	cryo, cryogenic, receivers
Rebooting PowerPCs	2018-07-12 16:54	rhowie	computers:admin, computers:LynxOS, computers:PowerPCs, troubleshooting
Operational Bad Weather Policies	2018-07-12 16:35	rhowie	observations:operations, summit:weather
Receiver Optimization	2018-07-12 13:37	rhowie	observations:operations, receivers
Recovering Antenna 4 300 LO	2018-07-12 13:09	rhowie	receivers
Antenna Hangar Maintenance Schedule	2018-07-12 10:02	rchilson	Antenna, receivers
Compiling Software for PPC's (updated for git version)	2018-07-11 14:36	rchilson	computers:SMA software
Automated ivcurves in Priming Log	2018-06-30 22:13	rrao	receivers;observations:operations
PACU & Correlator Room Start Up & Shutdown Procedure	2018-06-27 22:07	pyamaguc	correlator, IF/LO, PACU
Summit Emergency Escape Maps	2018-06-05 16:30	sradford	emergencies, observations:operations, safety, summit:weather
Mauna Kea Emergency Procedures	2018-06-05 16:30	sradford	Emergency, Procedures, safety
Mauna Kea Emergency Phone Numbers	2018-06-05 16:30	sradford	emergency, Kea, Mauna, Maunakea, Numbers, Phone, safety
Cryostat Warmups, Cooldowns and Troubleshooting Procedures	2018-06-04 15:28	rchilson	emergencies, observations:operations, receivers, troubleshooting
225 GHz tipper	2018-05-12 14:12	sradford	summit:weather
Reducing pointing data for RxB-RxA feed offsets	2018-05-03 11:57	nimesh	optics, pointing, Procedures, receivers, software
How to get fringes with the JCMT	2018-04-26 11:53	rrao	VLBI EHT

Maintain: Documentation (operations log)

Minor software fixes

reply #35479

Attila Kovacs

2018 Jun 12 20:19:59 UTC

Categories: General, Software
Antennas: 1,2,3,4,5,6,7,8
entered by: akovacs

A few very minor software fixes have been deployed, for:

- `statusServer`: Fixed counting of scans (occasionally a scan fell causalty to a poorly handled circular buffer wrap around -- at every 5 minutes).
- `dataCatcher`: `modeInfo` file (not used by `mir`) had bandwidth still from the ASIC days; DSM_AS_ANT_STATUS_V11_L could have negative values (now 0 or 1 exclusively).
- `ipoint`: Fixed waiting for unflagged scans.

The changes have been tested to a relevant extent. Data files look OK (non-zero), scan counting works, and `ipoint` produces meaningful results.

Nonetheless, in case of trouble `statusServer` & `dataCatcher` can be reverted back to the previous stable version using the same procedure as before (the `.stable` versions are now the ones used without major issues over the past week).

If `ipoint` has new issues, you can revert back to the prior version by:

```
> cd /application/bin
> cp ipoint.stable ipoint
```

as `root` on `hal9000`.

BIG dataCatcher problem 6/1 -- 6/4

reply #35449

Attila Kovacs

2018 Jun 05 03:16:53 UTC

Category: General
Antenna: none
entered by: akovacs

I accidentally introduced a really horrible bug in dataCatcher, which meant that pretty much only zeroes were written into the mir data files 6/2 through 6/4. It's a really truly horrible trainwreck that I caused.

Ryan only noticed the problem when trying to set delays during priming on 6/5. Until then, the problem went entirely unnoticed.

Fix

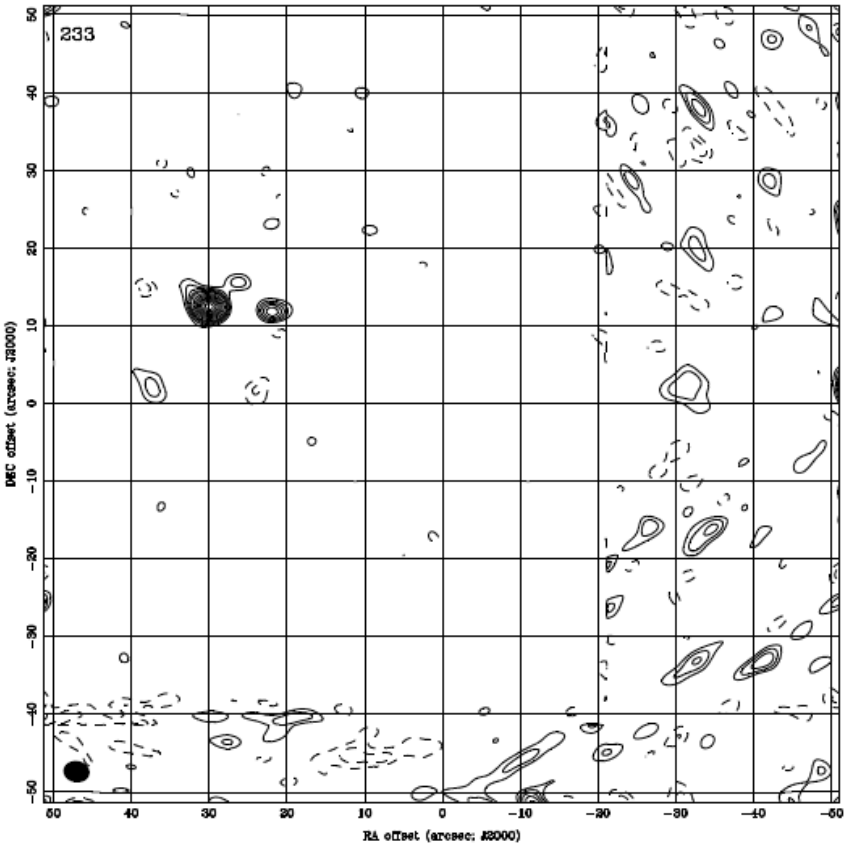
Fix problems that arise, and preemptively resolve issues identified in software.

Fix: Tracking of Solar System sources

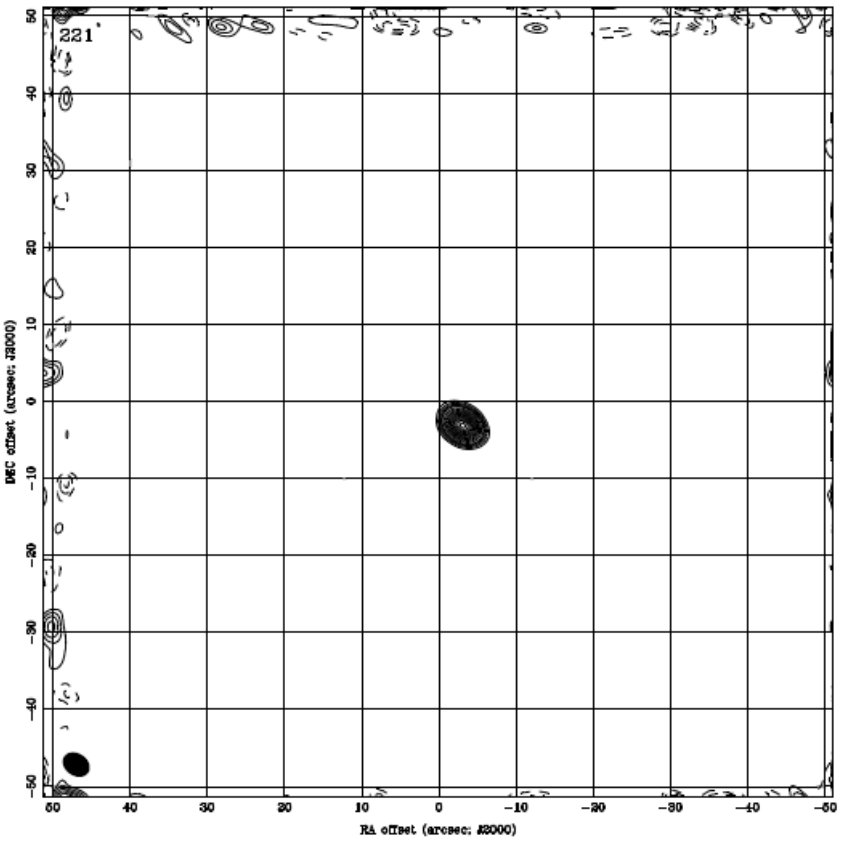
Ephemeris time lookup offset (TT vs UT)

(explains why planets, asteroids, comets were not properly phase centered before.)

Phaethon

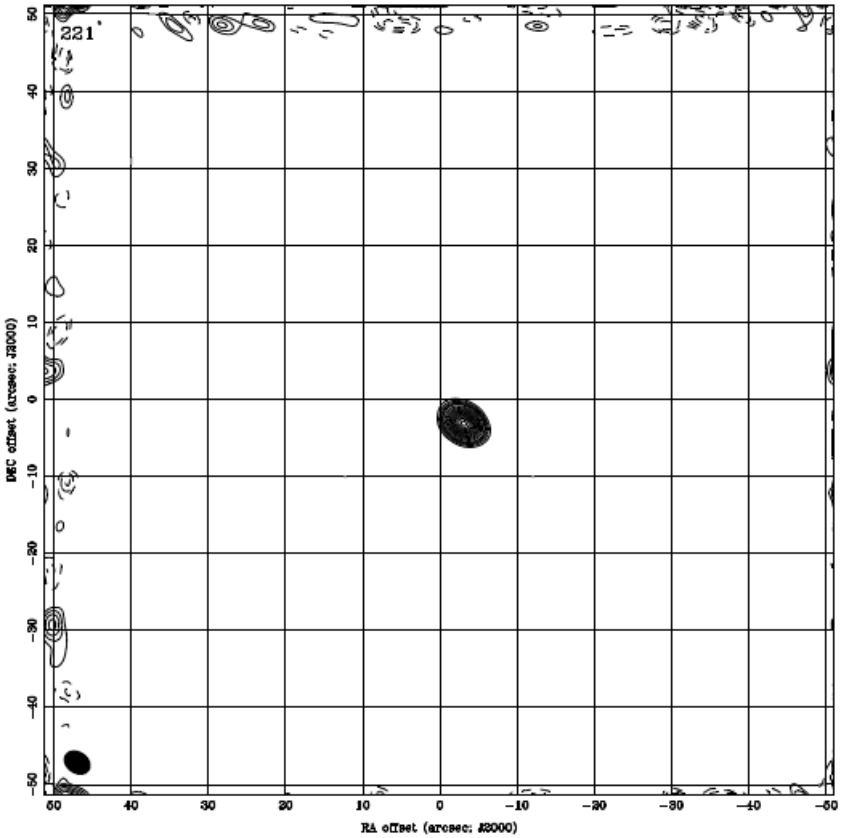


2017 Dec. 15

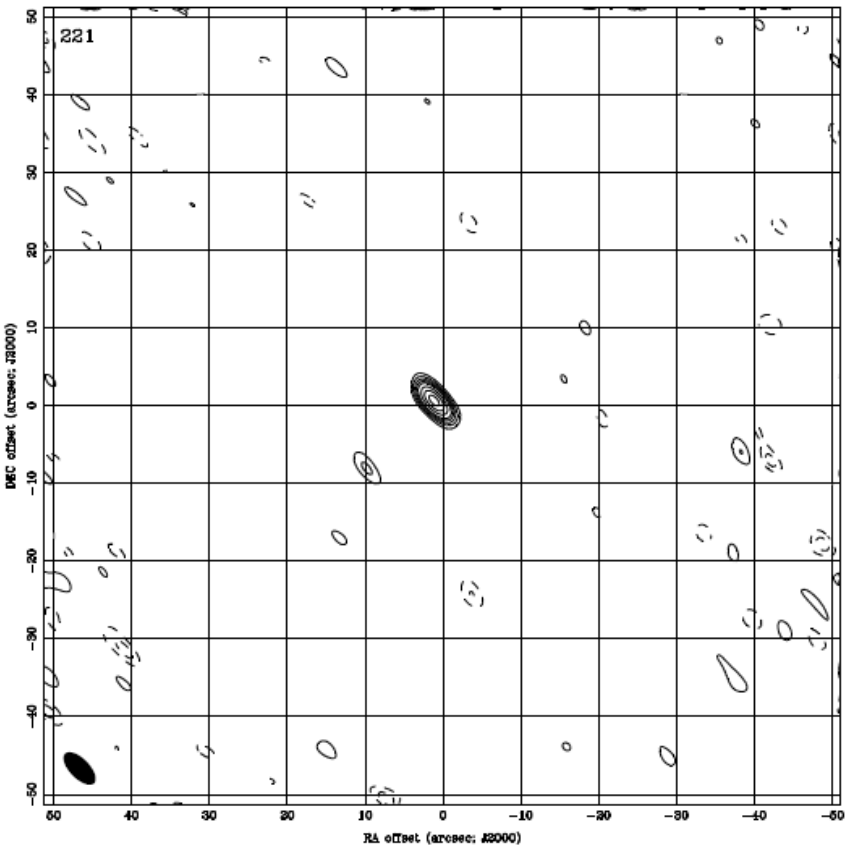


2017 Dec. 16

Fix: Nutation correction (NOVAS)



NOVAS 2.0
(2017 Dec. 16)



NOVAS 3.1
(2017 Dec. 24)

NOVAS 3.1 has much improved nutation model, improving systematic pointing by up to 3”.

Fix: Flagging

System tracks ~20 critical antenna-based conditions

- **Expose hidden flags**
- **Detect relevant issues**
- **Aggregate flags for scans**
- **Receiver-wise flagging support**

Improve

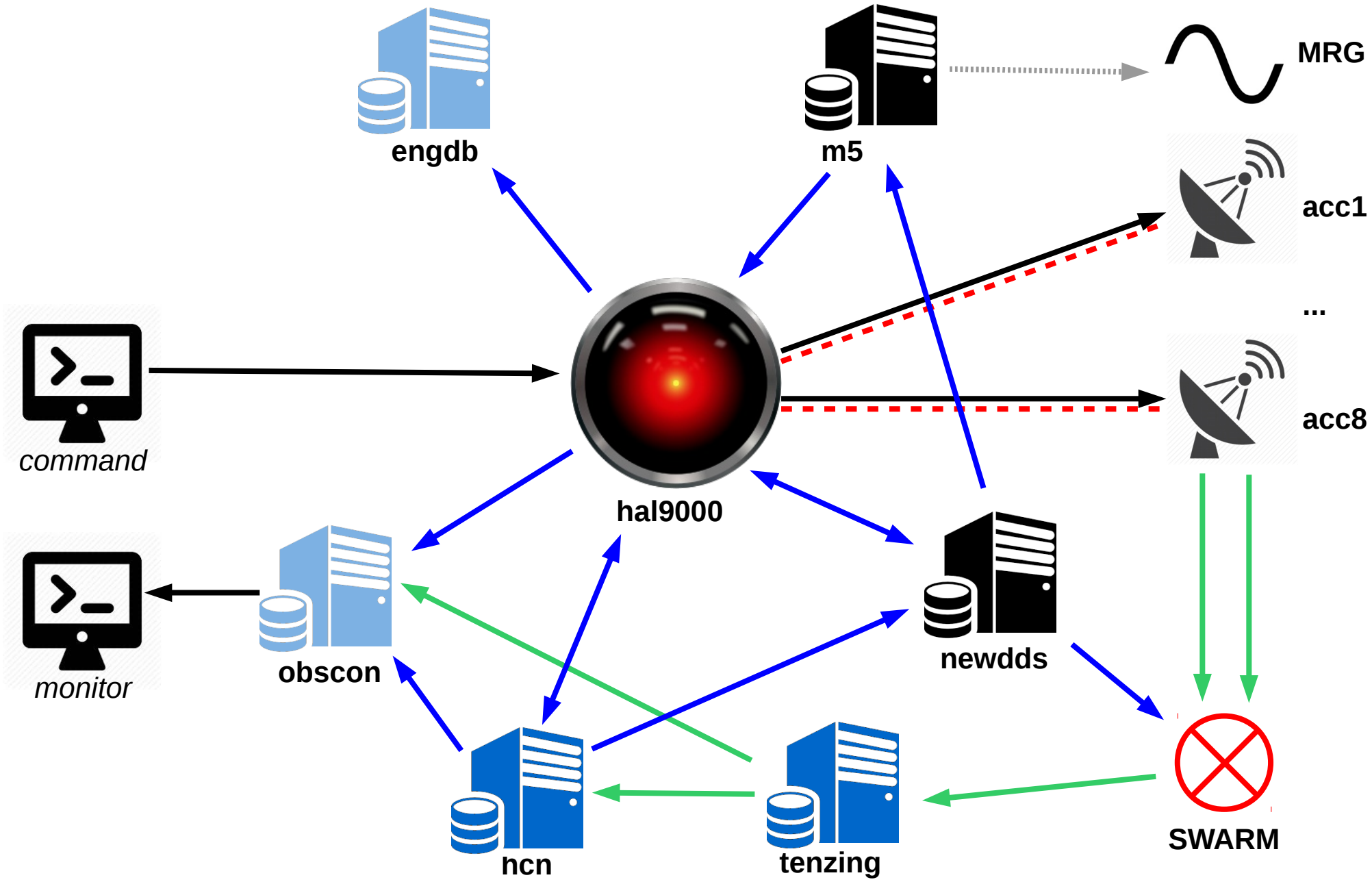
Increase the observing efficiency and scientific throughput of the SMA.

Improve: Overheads

- **“Sleepless” programs and scripts**
- **Much faster & more reliable interferometric pointing**
- **Faster & better source position checking**

- **Faster priming (tuning)**
- **Faster calibration (bandpass)**

Improve: design

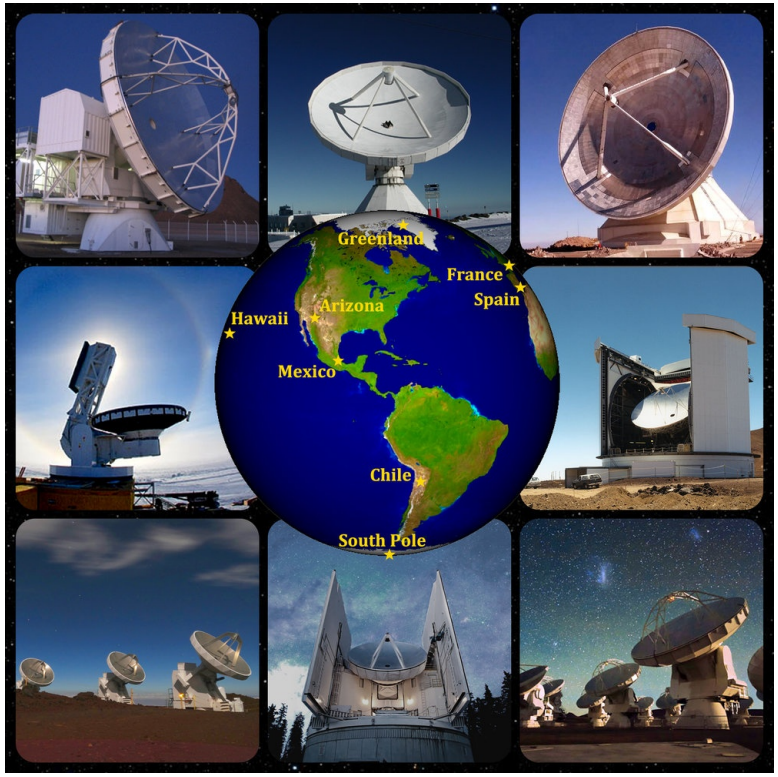


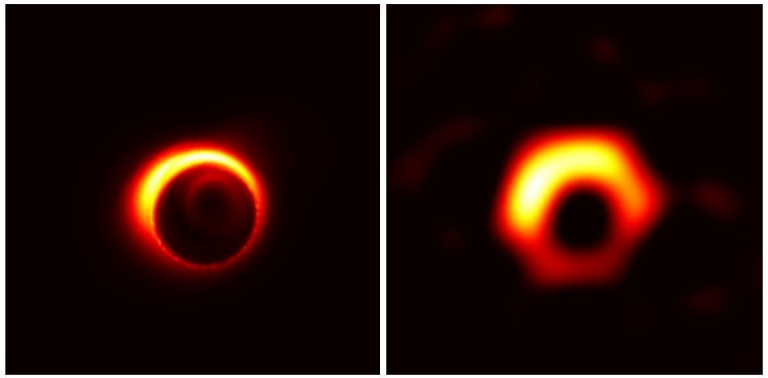
Improve: design

- **Less is more…**
  - More bug-proof
  - Easier to follow
  - Easier to maintain
  - Easier to extend

Improve: VLBI / EHT

- **Support EHT observations**
- **Seamless EHT operation**





model

simulated observation

Improve: Regression testing

- **Test before deployment on live system**
- **Unit tests for functions where appropriate**
- **Simulator for real-time behavior**
- **… but needs more man-power**

Enhance

Develop new capabilities to keep the SMA at the forefront of (sub)millimeter interferometry.

Enhance: wSMA - IF bandwidth

- **Prepare for increased bandwidth**
  - **combine** (extra SWARM segments & speed)
  - **transfer** (REDIS → direct TCP/IP stream)
  - **archive** (dataCatcher)
  - **analyze** (dataCatcher)
  - **monitor** (corrPlotter)

Enhance: wSMA - New receivers & tuning

- **Overhaul Rx tuning**
  - Focus on operations vs. engineering
  - Modular low-level (C) controlled via ‘scripts’ (Python)
  - Faster, simpler, & more reliable (e.g. lookup tables)

Enhance: New observing modes

- **On-the-Fly (OTF) mapping**
- **Hybrid (Total Power + Interferometric) Imaging Mode**
- **High time-resolution mode**

Enhance: Hybrid Mode

Single Dish

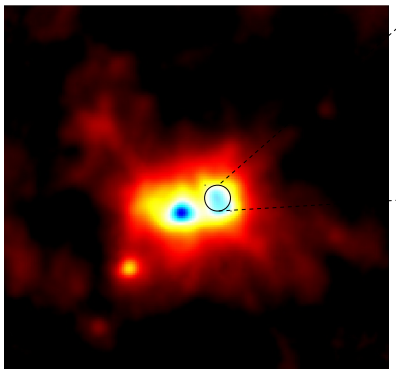
Observing sequence:

0.16s - on A
0.32s - on B

~3 Hz chop

A

B

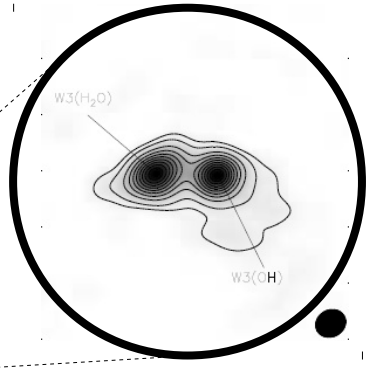


λ/d < *L* < chop

Interferometric

Observing sequence:

0.64s – Walsh steps 1-64



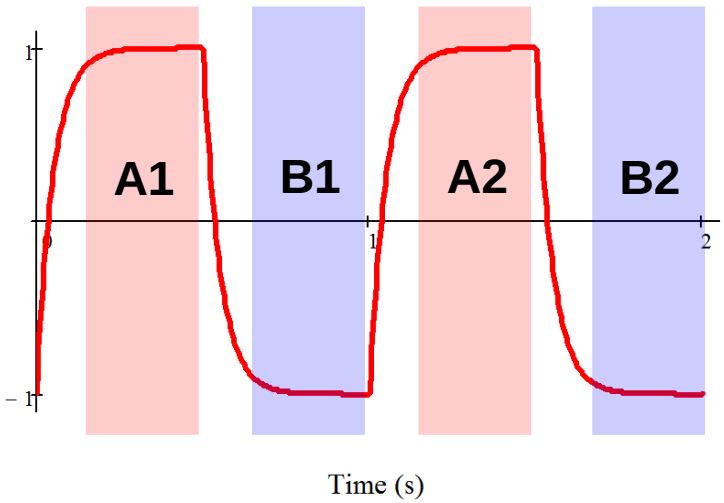
λ/D < *L* < λ/d

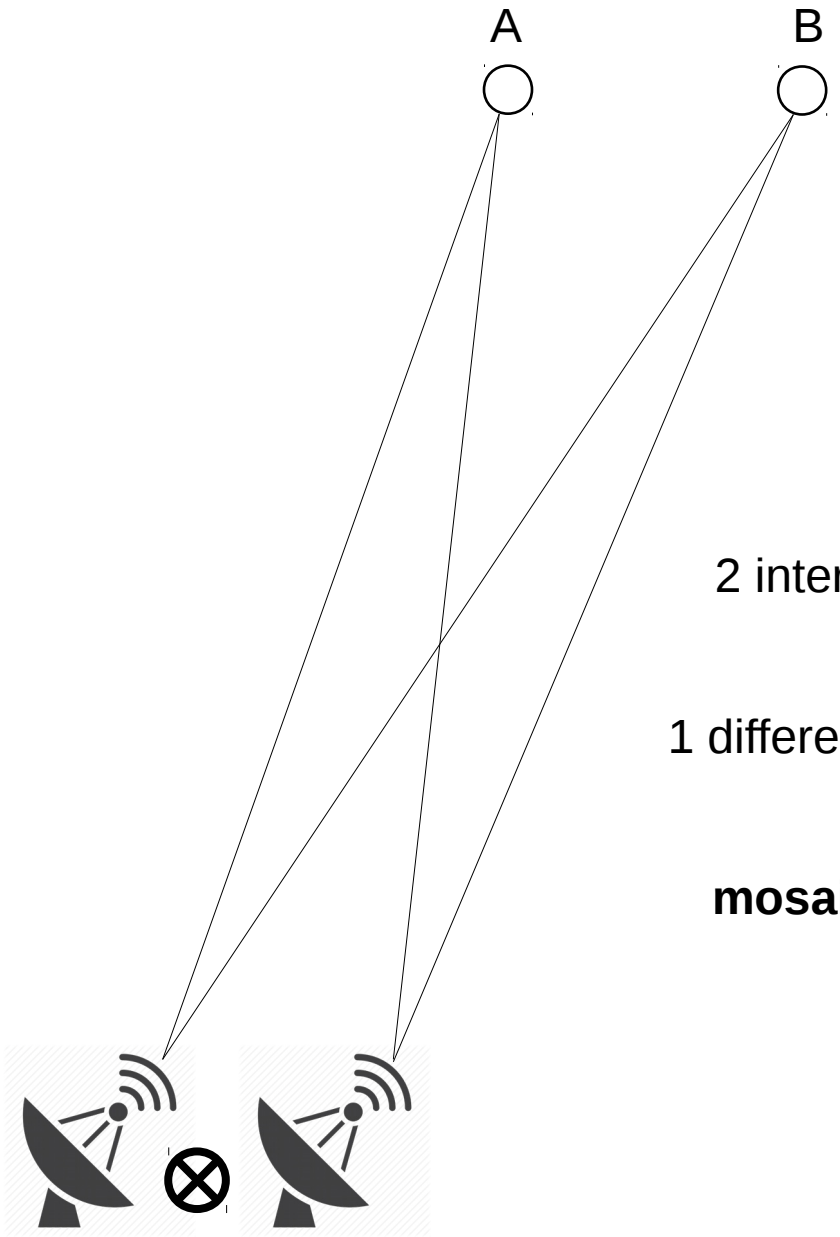
Enhance: Hybrid Mode

Observing sequence:

0.16s - **A1**: Walsh 1-16 on A
0.32s - **B1**: Walsh 1-16 on B
0.48s - **A2**: Walsh 17-32 on A
0.64s - **B2**: Walsh 17-32 on B
0.80s - **A3**: Walsh 33-48 on A
0.96s - **B3**: Walsh 33-48 on B
1.12s - **A4**: Walsh 48-64 on A
1.28s - **B4**: Walsh 48-64 on B

+ switching time….





2 interferometric fields
(A,B)
+
1 differential primary beam
(A-B)

mosaic to cover field

$\lambda/D < L <$ chop

Enhance: Array / subarray control

- **Command the ‘*array*’ vs. antennas**
- **Add/remove project antennas on the fly**
- **Split mode** (e.g. 6 science + 2 engineering)

Enhance: Online monitoring tools

```
| LastIntruder 09h06m  Tue Jul 17 13:53:54 2018   TJD 2458317.08  LST 23:13:20 |
| Project: 14959 - 2018A-H003 (PI: Lennox Cowie)                  *Sun:  54 -25 |
| Observers: Shelbi @ Cambridge x269              Antennas: 1 2 3 4 5 6 8       |
| Source: A2390RG              RA(2000) 21:53:34.050  DEC(2000) +17:42:40.000 |
| Vel 0.00 km/s LSR   HA=+1.315 RA(App.) 21:54:27.465  DEC(App.) +17:47:55.121 |
| Planet dist.=0.0000 AU,dia=0.0"    Polar dx=0.188", dy=0.416", dut=0.070 s   |
| @ SMA: +2.2C  66%  626mb  6.2m/s@228deg   225/350Tau:0.184/stale PM: 72.5/1.2|
| RxA  233.62000 GHz (s01) LSB           RxB  233.62000 GHz (s03) LSB          |
| Integration time  11.1/ 29.7, 4 more scans remain for this source            |
|Ant/Pad  1/5      2/4      3/1      4/9      5/12     6/23     7/7      8/8   |
|Az/El  267/71   267/71   267/71   267/71   267/71   267/71    11/26  267/71   |
|SunDist 130.2    130.2    130.2    130.2    130.2    130.2     65.8    130.2   |
|Drives   on       on       on       on       on       on       off      on     |
|Choppers OK-FC    OK-FC    OK-FC    OK-FC    OK-FC    OK-FC    OK-FC    OK-FC  |
|M3Doors  open     open     open     open     open     open     close  open     |
|G-Y    1-1/1-1  1-1/1-1  1-1/1-1  1-1/1-1  1-1/1-1  1-1/1-1  0-1/0-1  1-1/1-1  |
|IF/LO    --/--    --/I-    --/--    --/--    I-/I-    I-/I-    --/--    I-/I-  |
|Dwr/Cal 4.2DSky  4.2/Mov  4.4/Sky  4.7/Sky  4.9/Sky  4.3DSky   52DSky  4.0/Sky|
|Tsys2(K)   153V     143V     353r     184V     182V     217V       38     161V  |
|Tsys1(K)   132r     168r     147V     217r     186r     170V   wacko     174r  |
Tue 11:57:59 (jberghuis) script killed
Tue 11:58:34 (shostler) how did it go tonight?
Tue 11:58:40 (jberghuis) things are smooth. i worry a little bit about ant3.
Tue 11:58:40 (jberghuis) looked like it was declining a while back. rebooted
Tue 11:58:40 (jberghuis) it. seemed to help a little
Tue 11:59:13 (shostler) cool.
Tue 11:59:25 (shostler) automatic pointing has been fine?
Tue 11:59:46 (jberghuis) no complaints.
Tue 12:00:11 (shostler) great. Anything else I need to know?
Tue 12:00:27 (jberghuis) only that this script started a bit late. not sure if
Tue 12:00:27 (jberghuis) that effects anything on your end
Tue 12:00:56 (shostler) probably not, but I will check, make sure we get
Tue 12:00:56 (shostler) everything.
Tue 12:01:06 (jberghuis) perfect. ok. thats it
Tue 12:01:15 (shostler) I am all set, so if you are good, please feel free to
Tue 12:01:15 (shostler) head out when you are ready.
Tue 12:01:19 (shostler) Thanks for first shift!
Tue 12:01:29 (jberghuis) np. have a good day. we drive
Tue 12:02:28 (shostler) laters!
Tue 12:46:24 (gpetitpa) Hi. If the phase improves, we could use some flux
Tue 12:46:24 (gpetitpa) calibration data.
Tue 12:46:45 (shostler) ok
Tue 12:47:41 (gpetitpa) Thanks
```

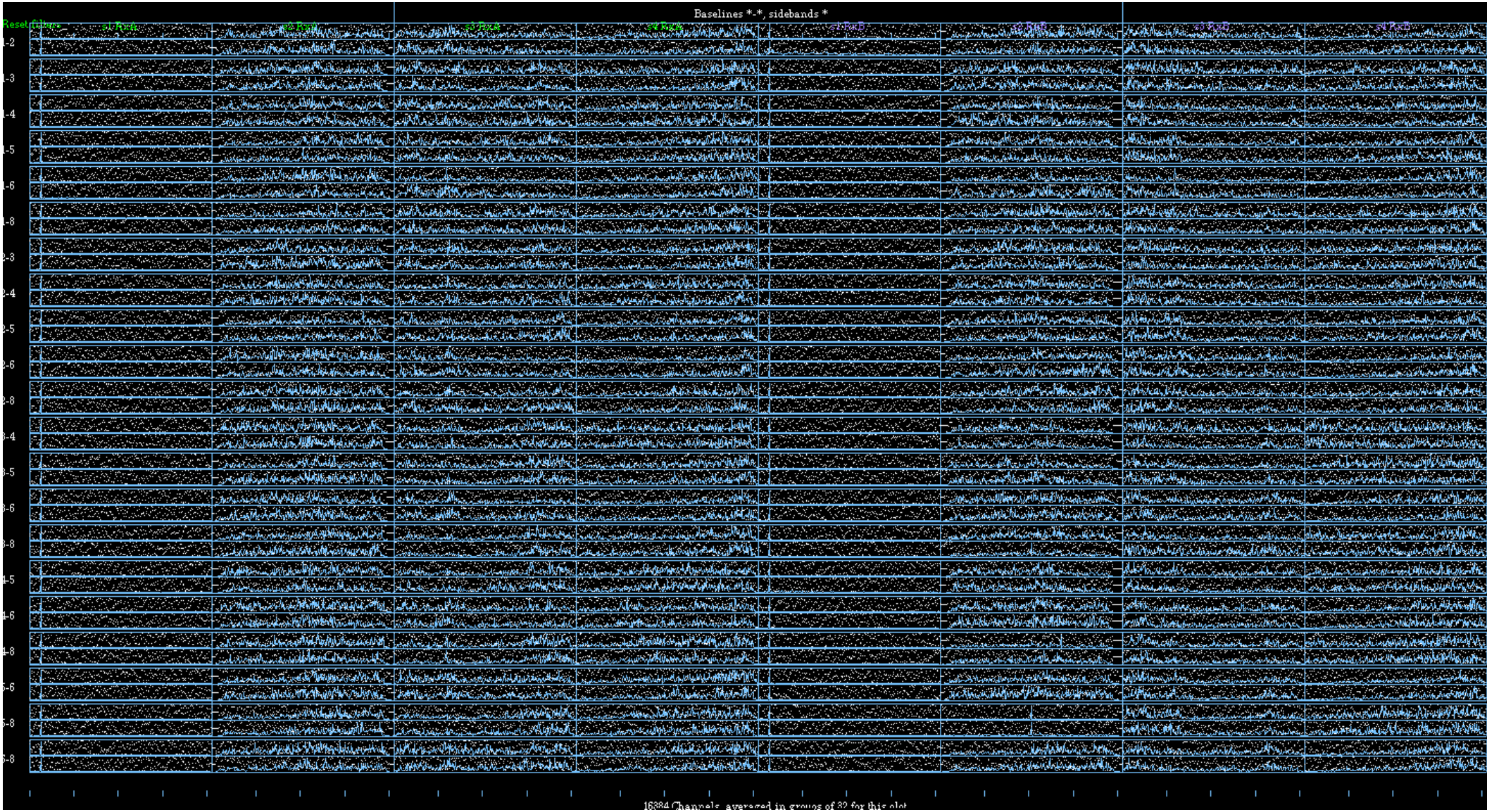
```
| SMA Antenna-1    tracking     A2390RG   Sun Safe Minutes:    500, 120 required
| on pad: 5 (hardware ID)                 Sun Dist: 134.8 deg
|    LST       UTC       TJD            Sun RA/Dec: 07h47m / +21d02m
|  23 17 46  13 58 18  2458317.082958     Sun Elev: -24.3 deg
|  H.A.: +1.3885      Error:  -0.005 sec
| J2000/J2000   RA            DEC         SUB_TILT:       -7 cts, -0.03"
| CATALOG   21 53 34.050   +17 42 40.00   SUB_X:     2169 cts, 2.169 mm
| APPARENT  21 54 27.465   +17 47 55.12   SUB_Y:    -2035 cts, -4.070 mm
| RaDecOFFSET(")   0.00           0.00    SUB_Z:     9991 cts, 4.996 mm
|             AZIM            ELEV        HOME OK  CHOP OK  XYZ OK
| CMD     267  35 21         70 11 53
| ACTUAL  245  59 34         69 49 53      TILTX(V) =  -0.04  TILTY(V) =  -0.14
| ERROR    27684.1"           4332.4"      TILTSX(") = +21.5  TILTSY(") = -44.5
| PMODELS(")(     2)             (   455)  TILTGX(") = +20.6  TILTGY(") = -43.0
| OFFSETS(")    -1                 -2      TILTEL(") = +20.6  TILTAZ(") = -42.1
| RxOFFSETS"(230+240) A1=-0.10 A2=1.45     pTLTEL(")=  +6.3   pILTAZ(")= -27.0
| REFRACTION: 16.7 " (radio)               DtEloff(")= +14.3  DtAzoff(")= -15.2
| CONT1DET1:  1397.5mV 0.430uW -33.67dBm   TILTCORRECTION: 0
| CONT2DET1:  1011.7mV 0.165uW -37.83dBm
| SYNCDET_IF1: 0.406uW  v2f_IF1: 0.406uW  rms= 8.83  min/max=4339/4359
| SYNCDET_IF2: 0.159uW  v2f_IF2: 0.159uW  rms=11.46  min/max=3793/3812
```

```
Flags for scan at 13:56:14 on  7/17/2018, current time: 13:56:18 on  7/17/2018

[Legend]:  o = OK, B = BAD!, * = Ignored/OK, ! = Ignored/BAD, - = offline

    Condition        1 2 3 4 5 6 7 8        Condition        1 2 3 4 5 6 7 8
    ================================        ================================
 1. Ave. Tracking    B B B B B B - B    17. Source Change    B B B B B B - B
 2. Bad Samples      o o o o o o - o    18. Source Mismatch  o o o o o B - B
 3. Cal. Vane        B o B B B B - B    19. Track Stale      o o o o o o - o
 4. Chopper Pos.     o o o o o o - o    20. Wacky Offsets    o o o o o o - o
 5. Coord Mismatch   o o o o o o - o    21. Waveplate Moved  o o o o o o - o
 6. Dewar Warm       o o o o o o - o    22. Miscellaneous    o o o o o o - o
 7. Drives Off       o o o o o o - o
 8. Feed A Mismatch  o o o o o o - o        Operator Flag    o o o o o o - o
 9. Feed B Mismatch  o o o o o o - o
10. IRIG Time        o o o o o o - o
11. M3 Door Closed   o o o o o o - o
12. Optical Point.   o o o o o o - o
13. Peak Tracking    B B B B B B - B
14. RxA              o o o o o o - o
15. RxB              o o o o o o - o
16. Shadowed Ant.    o o o o o o - o
```

Enhance: Online monitoring tools



corrPlotter (X11)

Enhance: Online monitoring tools

- **Web-based tools** (login / firewall / X11 forwarding)
- **client-side plotting** (server CPU load)
- **Conserve network bandwith** (plotting)
- **Focus on operations vs engineering**

Enhance: Diagnostics and alarms

- **Diagnose sooner**
- **Diagnose more**
- **Notify smarter** (operators vs. engineers / errors vs. warnings)

THE END