GOAL

- To provoke rollicking discussion
- Please interrupt me*

*There will be no wholly gratuitous pictures in this presentation.

An Inventory of UTC Dependencies for IRAF

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NOTE

- Only talking about the Y2K-like aspects

- This is a technical issue – and philosophical

- Other complications

- …and opportunities

  - Moving forward recent IAU coordinates work

  - Expanding the conversation

PRE-Y2K NEWS ITEM

"The oldest computer in the world destined to suffer from the millennium bug resides in a museum in Liverpool, England - as a Renaissance artifact."

Y2K News Item, continued…

"The nearly 400-year-old instrument, which predicts the position of the planets, will stop working at the dawn of the 21st century…"

…CONTINUED

"An unknown craftsman in 1600 built the equatorium, which operates through a system of rotating discs and arms, to calculate the future positions of the sun, the moon, other planets, and eclipses. But the last date the creator inscribed was in 1999."

Y10K Bug

To combat the Y10K bug, the Long Now Foundation, builders of the 10,000 year clock, encourages dates to be written like:

6 October 02011

This is, of course, how a clock designed to last until the 121st century must display dates.

COST ESTIMATES ARE COSTLY

- This was touched on yesterday
- Aspects of Systems Engineering:
  - Cost
  - Schedule
  - Performance
  - Risks
- Chicken & Egg
  - No allocation of resources until a need is demonstrated
  - But can't demonstrate need without $$

UTC VERSUS Y2K

- UTC is broader and less clear-cut
- Systems (HW + SW + process) either assume
  - UTC == Universal Time (UT1), or
  - UT1 = UTC +/– DUT1   (*or both*)
- In the first case, we need to introduce the new distinction   (*nomenclature?*)
- In the second case, we need to vet as Y2K (*0.9s*)
- Algorithms have to accommodate changes
- New infrastructure to supply UT1 and/or DUT1
- Requirement for leap second DB doesn't vanish

UTC VERSUS Y2K #2

- Unlike Y2K,

    the urgency is *artificial*

- Cry wolf effect

- Y2K was real, but perceived as fake after the fact

- UTC issue is real, but *invisible* and will seem fake when explained

10

IMAGE REDUCTION & ANALYSIS FACILITY

- Image processing package of packages

- Many hundreds of applications "tasks"

- Developed by NOAO

- External packages by others

- Widely used worldwide

- > 10,000 journal articles cite IRAF

IRAF #2

- Standard processing touchstone

- Legacy aspects

- Current pipelines

- Utility chores

- Hundreds of staff years invested

- 17,000 files – Million-plus lines

- Roughly double for external packages

IRAF #3

- Highly portable (could live forever)

- Virtual Operating System

- Layered on host dependent kernel

- Controlled programming environment

  - Own language, "SPP"

  - Own scripting language, "CL"

  - Host level callable (new frameworks)

Y2K REMEDIATION

- http://iraf.noao.edu/projects/y2k/y2kplan.html
- Search terms like "19", "century", "year"
- ~130 files
- Variety of mitigation from none to writing new interface
- Adapt applications to use new interface
- 3 calendar years
- Similar number of FTEs
- Coordinated with NOAO activities (TCS, instruments, scheduling, admin, …)
- Coordinated with community (FITS)
- Documentation! Test! Deployment!

SEARCH TERMS (*SYSTEM DEPENDENT*)

○ Roughly in decending order:
- UT(C), GMT, (M)JD, DUT, LST
- Hour, minute, second
- Year, month, day
- Solar, sidereal
- Clock & calendar

○ Too general:
- Date & Time

○ Can't see the forest for the trees:
- Leap second

15

SEARCH TERMS #2

- System dependent

- Project dependent (layered infrastructure)

- Combinations of terms even more so

- Search could go on forever

- Eventually stop and wait for bugs to appear

- Code written by many programmers

  - over many years

  - even with coding standards

UTC Inventory

- 1312 source files (out of 11,600)

    - 250   ut (23 utc)
    - 38   gmt
    - 158   jd (63 mjd)
    - 67   lst

    - 857   second
    - 66   minute
    - 145   hour

    - 156   day
    - 68   month
    - 100   year

    - 20   sidereal
    - 65   solar
    - 10   calendar
    - 73   clock

SOME TERMS ARE TOO GENERAL

- 1447   time
- 1246   date
- 2933   total

- Similar numbers for documentation

- Composite searches very finicky

SOME MITIGATION ACTIVITIES

- Construct inventory
- Vet inventory
- Code rewrites
- New library code
- New infrastructure
- Rewrite applications to benefit
- Documentation
- Coordinate with IRAF community
  - External packages
  - Release new versions
  - Support both old and new
  - Fix bugs as they appear

Iterate!

ASTRONOMICAL SOFTWARE

⚬ Discussions suggest that an overview of software in astronomy is needed

- Astronomy is a compartmentalized discipline (the universe is big)

- Infrastructure is often invisible

- Recent trends

- Looming projects

CLASSES OF SOFTWARE

- Observing preparation tools:
  - Phase 1 planning
  - Phase 2 preparation
  - Exposure calculators
  - Mask preparation
  - Observing block preparation
  - Scheduling

ASTROMETRY

- In many other classes
  - Plate solvers
  - Coordinate system transformations
  - Astrometry.net

CATALOG HANDLING

- Source extraction
- *etc*

TELESCOPE CONTROL SOFTWARE (TCS)

- Pointing model
- Tracking
- Non-sidereal rates
- Servo loops
- Messaging
- User interfaces
- Status feedback
- Active optics
- Dome functions

INSTRUMENT CONTROL SOFTWARE

- Exposure management
- CCD readout (or equivalent)
- Filter wheels
- Header metadata
- Advanced observing modes
- Observing sequences

DATA HANDLING SYSTEMS

- Pixel de-interlacing
- Cross-talk removal
- Merge telescope and dome metadata
- Quick look
- Quick reduce

DATA TRANSPORT SYSTEMS

- Data flow management
- Queuing (with timestamps)
- Long distance transport
- Filtering and switching
- Temporary copies
- *etc*

ARCHIVING

- Storage of multiple copies
- Data compression
- Checksums
- *etc*

PIPELINE PROCESSING

- Data reduction algorithms
- Catalog extraction
- Registration and differencing
- *etc*

PORTAL ACCESS

- GUIs
- Scriptable interfaces
- Batch aspects
- VO standards
- Science interfaces
- *etc*

VIRTUAL OBSERVATORY

- Comprehensive data models
- Formats and protocols
- Interoperability
- *etc*

ARCHIVAL DATA FORMATS

- World coordinate systems
- Y2K convention
- UTC convention(s)?
- *etc*

ASTRO INFORMATICS

- Semantics underlying it all
- Fancy data mining heuristics
- Need for coherent ontologies
- Combining data from
  - multiple epochs
  - multiple sources
  - multiple bandpasses
- *etc*

EMBEDDED SYSTEMS

- Often inaccessible
- Diverse vendors
- Some no longer exist
- Clocks are prevalent
- *etc*

EDUCATION / PUBLIC OUTREACH

- Came up before
- Will continue as an activity
- Also an opportunity, but…
- We aren't making it more intuitive
- *etc*

MODELING AND ANALYSIS

- The Mangle of Practice
- Need stable foundation for scientific discourse
- Where theory meets the real world
- Lots of ad hoc software written by non-programmers
- Lots of fancy algorithms

DESKTOP PROCESSING

- Class of software similar to IRAF
- Several other packages
- New paradigms emerging
- *etc*

CELESTIAL TRANSIENT EVENTS

- Very hot topic
- Dark Energy (SN Ia)
- Bestiary of all kinds
- Surveys (LSST, Pan-STARRS, SkyMapper, GAIA, LOFAR, SKA, ICECUBE, Fermi, …)
- Rapid autonomous follow-up
- Time is of the essence…

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ONE FINAL Y2K QUOTE

○ *We don't have any problems yet.... We'll deal with the problem in the year 2000.*

- Vladislav Petrov

[Russian Atomic Energy Ministry spokesman]

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