Tuesday (01/10/2012) Briefings

08:30	Intro and MACS Overview
09:40	Break
10:00	MACS/ADRS simulation architecture and integration with ATOS and TMA
11:00	Using MACS to simulate aircraft operations *Simulation Manager and Flight Deck Stations*
12:00	Lunch
1:00	Basic Air Traffic Control Operations.
1:30	Using MACS to simulate near-term air traffic control operations. *Focus ATD-1, Center/TRACON workstations, Scheduling, CMS*
2:45	Break
3:00	Using MACS to simulate far-term automated air traffic control operations. *Focus on Separation Assurance*
3:45	Developing MACS Software
4:30	End of day

A doctor, architect, and programmer were arguing over which was the oldest profession. The doctor said, “God took Adam’s rib to make Eve. This was surgery! Thus, medicine is the oldest profession.” The architect said, “No no! God took the Chaos and made the heavens and the Earth, which is sure the work of an architect, which is thus the oldest profession.” The programmer looked up from his keyboard, smiled slyly, and said, “And who do you suppose created the Chaos?”

Developing MACS Software

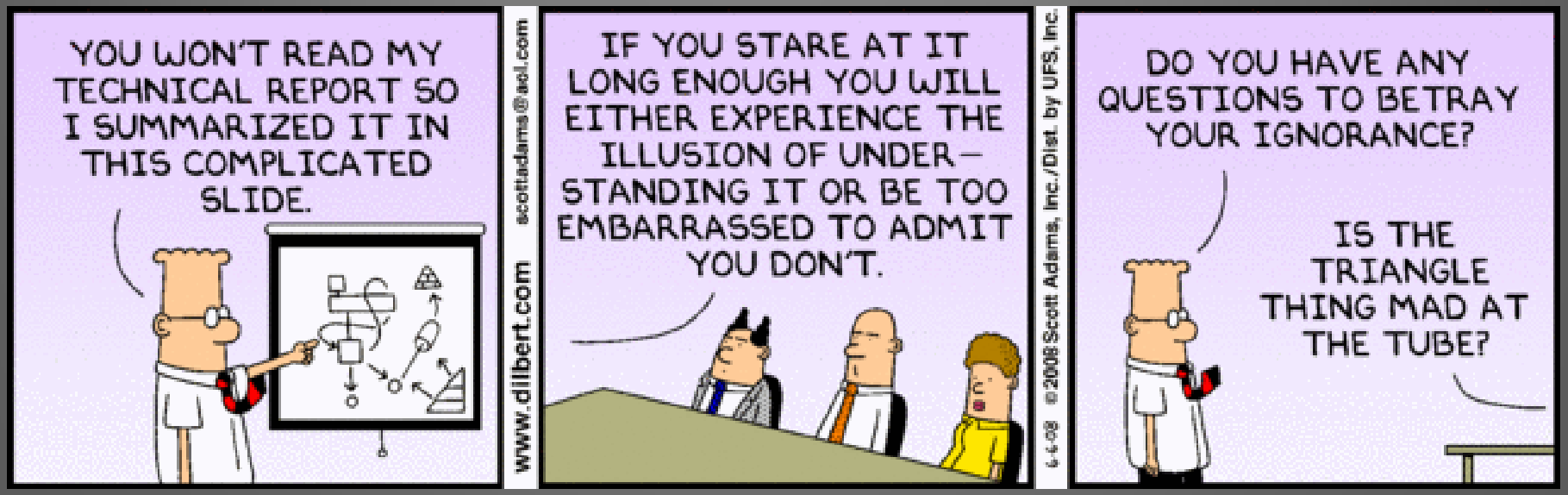
2,230 files, 415,000 LOC

Beware ye who enter here …

Al Globus, San Jose State University Research Foundation
Rick Jacoby, Dell, Inc.

Basics

- Developer Environment
- Threading and Distributed Processing
- Development Philosophy
- The Big Picture



Developer Environment

- MACS is 100% pure Java (ADRS is C)
  - 2,230 files, 415,000 LOC
- UI in Swing
- Parts are object oriented, others procedural design
- GIT for source code control
  - Each lab has its own branch
  - When stable and tested, merge into integration branch
  - After regression test, merged into master branch
- Mantis for issue and bug tracking
- Log4j for logging, may switch to java util logging
  - Each class (should) have its own logger instance
- There is a unit test (JUnit), but it covers little
- Most AOL developers use Eclipse on Windows
- Libraries for build and run all functionality
  - RXTXcomm, jython, jsapi, freetts, en_us, cmutimelex, cmulex, cmu_us_kal, log4j-1.2.13.jar

Git and Wiki Server Info

- Git server: https://aolgit.arc.nasa.gov/git/

Protocol	Access-Type	Example
SSH	**Read-Write**	git clone git@aolgit.arc.nasa.gov:MacsSource
GIT	Read-Only	git://aolgit.arc.nasa.gov/MacsSource.git
HTTPS	Read-Only	https://aolgit.arc.nasa.gov/git/

- Wiki server: https://aol1.arc.nasa.gov:8443
  - Macs-Documentation: End-User documentation
    https://aol1.arc.nasa.gov:8443/display/macs/Home
  - Macs-Development: Eclipse & SmartGit configuration screenshots
    https://aol1.arc.nasa.gov:8443/display/macsdev/Home

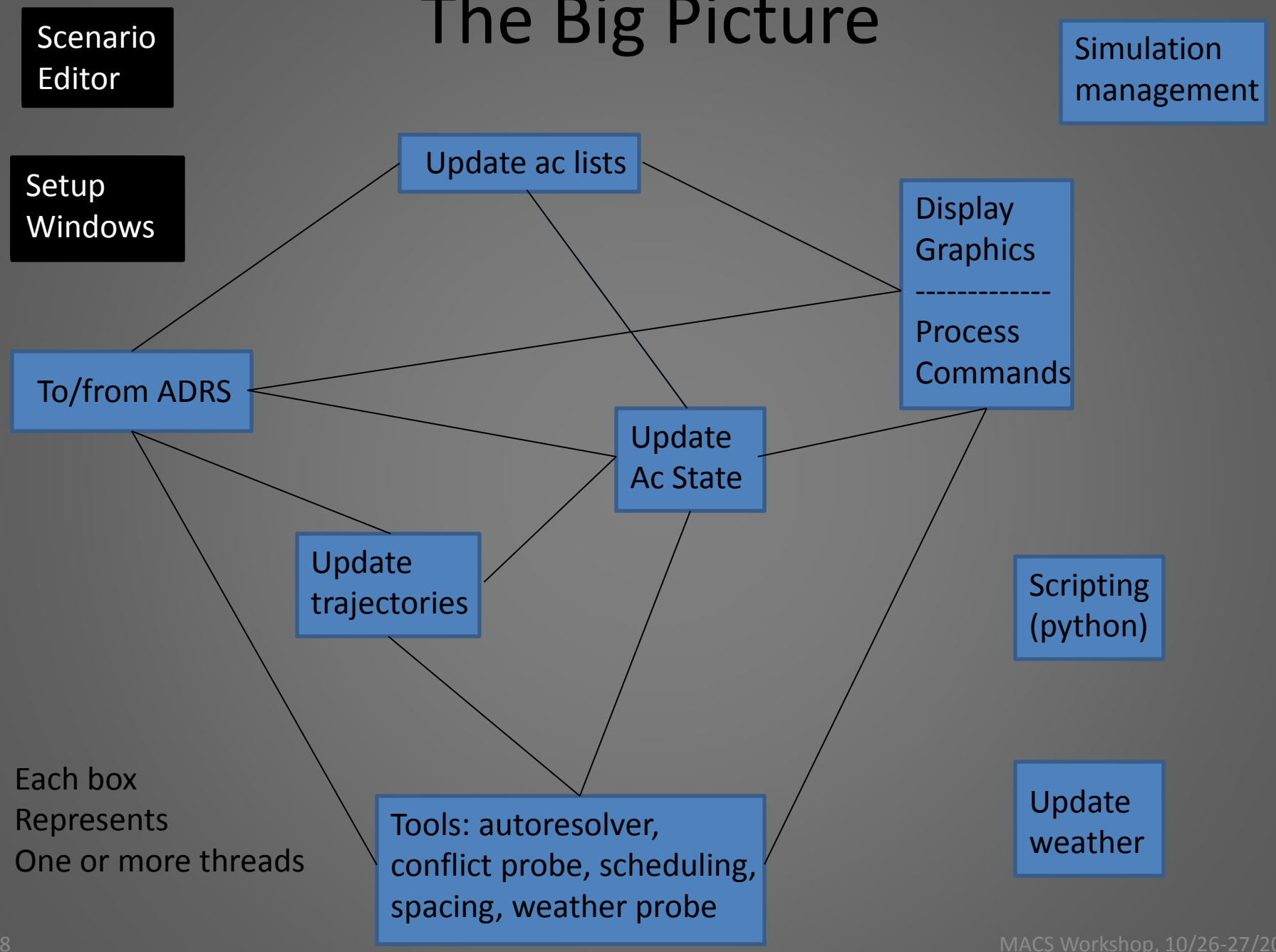
Bug-Tracking, CI Server & Mailing list Info

- Mantis Bug-tracking software
  - https://ofu.arc.nasa.gov/mantis/
- Continuous Integration Server
  - https://aolgit.arc.nasa.gov/hudson/
- Mailing list info
  - To subscribe, go to:
    - http://eos.arc.nasa.gov/mailman/listinfo/macshelp
    - macshelp@eos.arc.nasa.gov
- Contact Vic (vaibhav.kelkar@nasa.gov) for accounts

Threading and Distributed Processing

- MACS operationally usually runs on multiple machines
  - ATC stations, Pilot stations, Simulation control, Data collection
  - One jar, many setup options
  - ADRS for communication, usually on dedicated machines
- Each MACS runs many threads (up to 194)
  - Threads catch exceptions in periodicRunAction() and restart
  - NOTE:
    - if (foo != null)
      - return foo.aField; // foo may be null!
    - Synchronization is slow, can lead to deadly embrace
      - Assignment is atomic
    - Vector is synchronized, List is not
    - for(int I = 0; I < aVector.size(); i++_)
      - aVector.get(i) // NOT thread safe!
    - for(Foo f : Collection<Foo>) will throw concurrant list modification exceptions
    - See threads.AcManagerThread.AircraftList for efficient thread-safe list handling
- MACS can run on a single machine, most development in this mode
  - Add -adrs=offline -operator=Developer-Lite to command line
  - Can partially test distributed mode on single machine by running ADRS and multiple MACS on one machine
    - Not recommended for operational use

The Big Picture



Each box
Represents
One or more threads

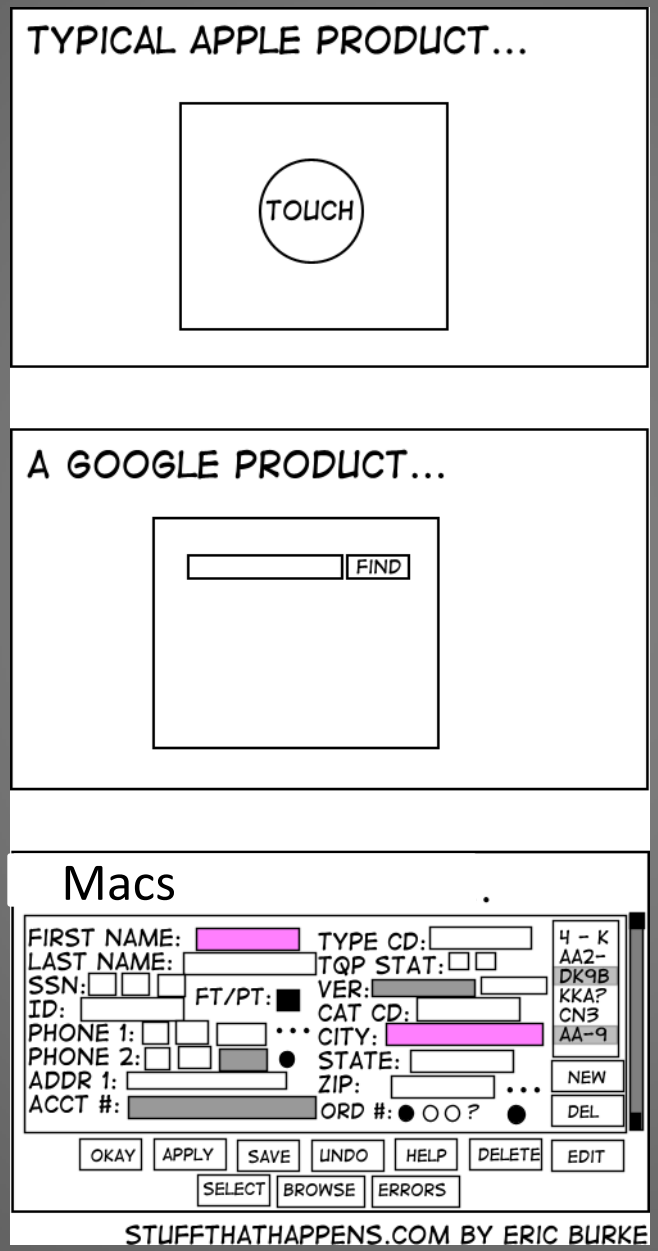
Philosophy

- Segregate air and ground side information
  - AcDescriptor.state for air side
  - AcDescriptor.atcData for ground side
  - Communicate through data link, not in the code!
- Check for null references, indices in bounds
- When encounter an error, log it and try to stumble on (if possible)
  - include stack trace: logger.error("msg", new Exception())
- When coding follow suit: in each part of MACS, try to be consistent with the existing code. We already have enough inconsistencies!
- Avoid redundant comments, do comment 'why?'
- Add, don't replace functionality

Add, Don't Replace Functionality

- Use the setup files/UI to turn on/off new capabilities
  - Save/restore to setup file
    - macsUtility.XmlUtility
    - displays.atc.atcDisplayData.Foo.getClassSpecificData()/setClassSpecificData()
  - Prompt user to save when closing setup window or exiting MACS
    - Call CommonSetupWindow.applySetupChange()
      - Calls applyChange(), which you write in subclass if needed
  - Be sure UI is updated when a new file is read (updateBody() is called)
- UI pattern
  - Add widgets to CommonWindow.jpanel
  - createBody()/actionPerformed()/updateBody() or updateSettings()
      - displays.common.DispUtils.addGBComponent
  - displays.common.GBPanel.java
    - uses macsUtility.Procedure.java
    - Regenerates panel on file read by calling createBody() from updateBody()
  - displays.common JMacs widgets
      - displays.common.JMacsFileMenu

ATC Windows & Views

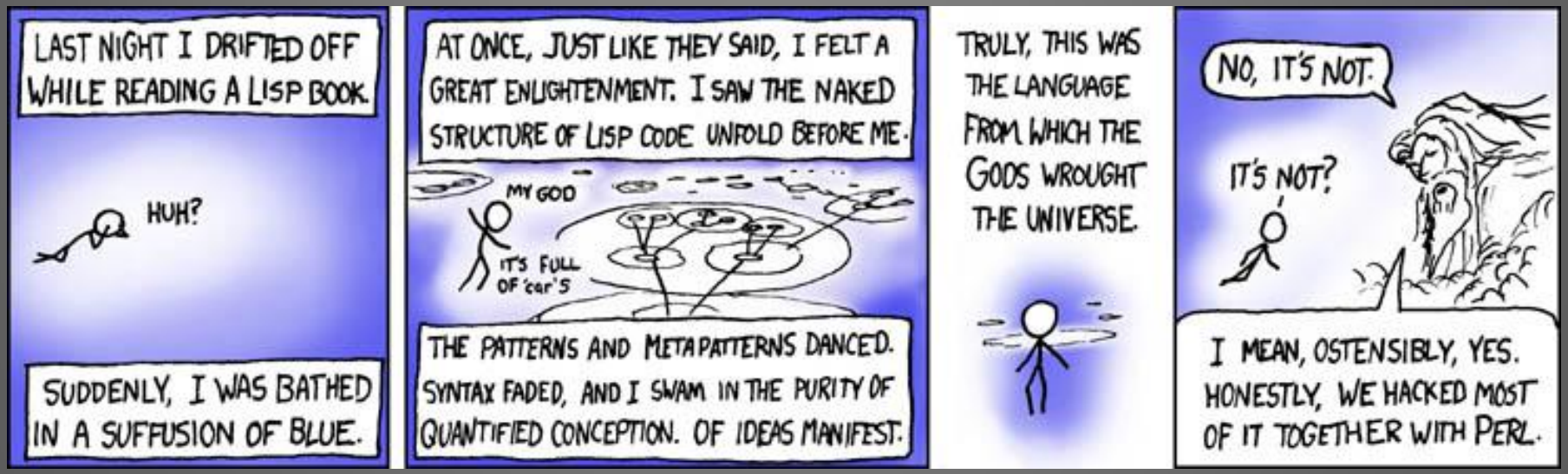


ATC Displays

- Different type of ATC display for each ATC function or domain
- Currently support DSR, STARS, TSD, OCEAN21, ERAM*

Run Time Inter-Machine Communication

- Data Logging
- ADRS
- macsComm



Data Logging

- Every time a controller or pilot does something, log it!
- Adding an event to existing log file
  - *dataCollection.DcEvent.java*
    - add *MY_EVENT(*EventClass*, DcTrigger, Text Description) to enum*
      - *EventClass determines log file*
  - *Call dataCollection.DcUtilities.logEvent(MY_EVENT, AcDescriptor, Object, String) or logMyClassEvent(…)*
- *To add new information to output*
  - *message.macs in the appropriate class (e.g., MacsCustomLogMsgEvent.java)*
    - *Add a field to store info*
    - *In constructor, set the field*
    - *Append to toString()*
  - *To modify header, add to DcUtilities.getMyClassHeaderStr()*
- Creating a new log file
  - dataCollection.DcLog.java – add MY_DC_CLASS_LOG to enum
  - Add class message.macs.MacsMyDcClassMsgEvent.java
  - Add method message.Msg.macsMyDcClass(args) -- call fireMessageEvent(new MacsMyDcClassMsgEvent(args))
  - Add getMyClassHeaderStr() to DcUtilities
  - dataCollection.DcUtilities – add call to macsMyDcClass(args)
  - threads.DcThread.java, add to handleMessageEvent()

Debug Logging

- Debugging log(4j)
  - Command line: add -Dlog4j.configuration="log4j.properties“ before the jar file name
- Sample log4j File
  - log4j.rootLogger=WARN, A1, FIL1
  - log4j.logger.traj4D.Traj4DEvaluator=DEBUG

  - log4j.appender.A1=org.apache.log4j.ConsoleAppender
  - log4j.appender.A1.layout=org.apache.log4j.PatternLayout
  - log4j.appender.A1.layout.ConversionPattern=%-5p\t%s\t%c.%M\t%m\t%d{HH:mm:ss,SSS}\t${macs.host}\t[%t]%n

  - log4j.appender.FIL1=org.apache.log4j.FileAppender
  - log4j.appender.FIL1.File=../MacsDebug/${macs.host}_log_${macs.fileTime}.txt
  - log4j.appender.append=FALSE
  - log4j.appender.FIL1.layout=org.apache.log4j.PatternLayout
  - log4j.appender.FIL1.layout.ConversionPattern=%-5p\t%s\t%c.%M\t%m\t%d{HH:mm:ss,SSS}\t${macs.host}\t[%t]%n

ADRS

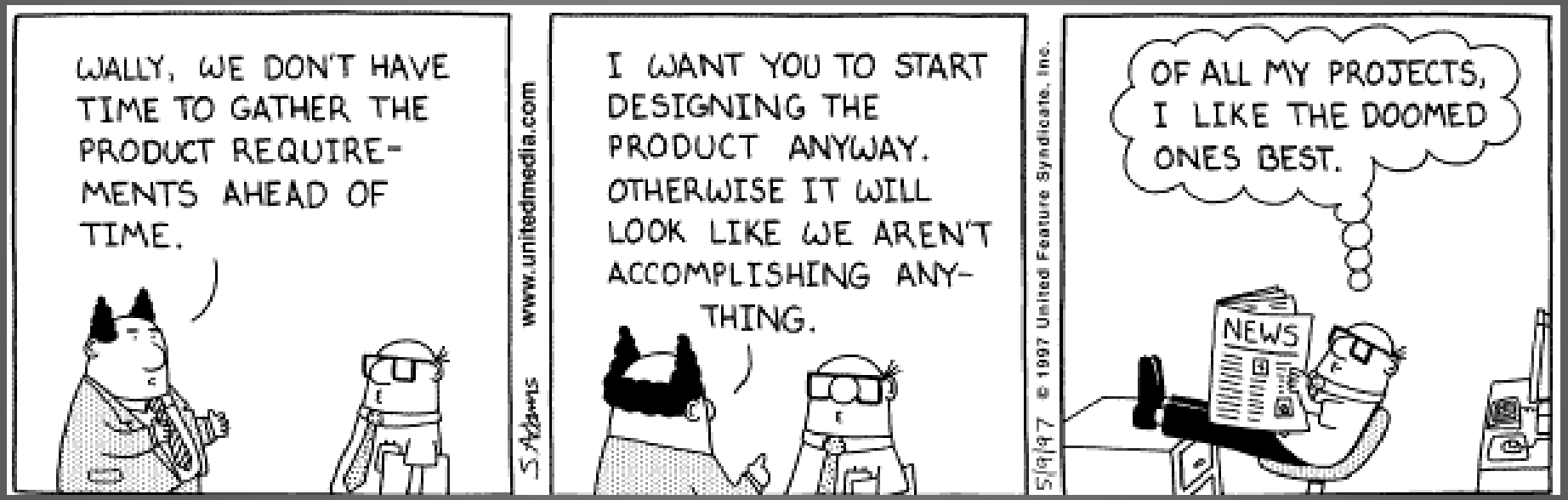
- Used for most inter-machine communication
- Communicates to non-Macs systems
- Written in C
- MACS: mpio.*.java
- What is communicated
  - Aircraft location, can include radar/ADS-B simulation
  - Datalink messages between aircraft and ATC
  - Share controller actions between ATC stations
- Multiple ADRSs common
  - Simulation control and pilots stations must share same ADRS
    - Pilot stations update ac positions for their sector
    - Simulation control updates all other ac

macsComm

- Pairs of controllers sometimes work together on a single sector.
- They are called “R side” and “D-side” meaning Radar and Data.
- macsComm keeps the display of data tags, spacing cones, trajectories synced
- When running two MACS on one machine, this package will give you lots of warning messages. You can ignore them or put
  - log4j.logger.macsComm.RdCommunicator=ERROR in your log4j properties file

Things to Know

- Key packages
- Useful stuff
- Traps



Key Packages

- commonObjects
  - aircraft, runway, waypoint, flight state, sector, trajectory, etc.
  - Partially generated by custom program: createCommonObjects
    - See commonObjects.Macs for input
    - See comments to know where to put custom code
- calculators
- displays – almost all the UI code here
- displays.setup – most of the setup UI
- dst
  - advisories, autoresolution, conflict probe, flight deck spacing, schedulers, atc spacing, traffic analyzer
- traj4D – trajectory code
  - Also in commonObjects.Traj4D and TrajPoint
  - Be VERY careful when modifying, tell me what you plan to do
    - "Rapid Generation and Utilization of Four-Dimensional Trajectories for Air Traffic Control and Management Applications in MACS," Al Globus, Richard H. Jacoby, Thomas Prevot, James K. Wong
- threads – most of the threads
  - CommonThread
  - DisplayManagerThread is for adding windows
- NOTE: jUnit and log4j are in the source tree

Useful Stuff

- macsUtility
  - Particularly Utility.java
- commonObjects.Tools.java
- displays.common
  - Particularly displays.common.DispUtils.java
- test.* -- JUnit unit testing
- NOTE: Macs runs Python scripts at sim time
  - simulation.scripting
  - Windows->Setup Panels->Scripting Setup

Traps

- macsUtility and gov.nasa.alsUtility have many of the same classes, use macsUtility
- What you think is incorrect behavior may well be the setup
  - I've spent days looking for bugs that turned out to be correct behavior given the setup options
- Reflection is used by some enums and names must match fields exactly
  - displays.timeline.TimelineField/displays.timeline.TimelineDisplayConfig
  - displays.timeline.MeterListField/displays.timeline.MeterListConfig
  - dst.scheduling.SchedulerField/dst.scheduling.Scheduler
  - displays.scenarioEditor.AcField/commonObjects.AcSimulationEntry
  - dataCollection.StateLogItem/various
  - dataCollection.TrajLogItem/various
- MACS generates a great deal of sometimes pointless output
  - Tsafe generates a lot of output to avoid JVM bug
- The scenario editor does things much differently than the other plan view windows

Testing


NOW TYPE "23" INTO THE FIELD.
OK.
HIT "SUBMIT."
OK.
SO AS BUGS GO, THAT'S "BAD," RIGHT?
YES, THAT'S BAD.
HEY, DO YOU SMELL SMOKE?
Copyright 2005 Hans Bjordahl
Bug Bash by Hans Bjordahl
http://www.bugbash.net/

Testing

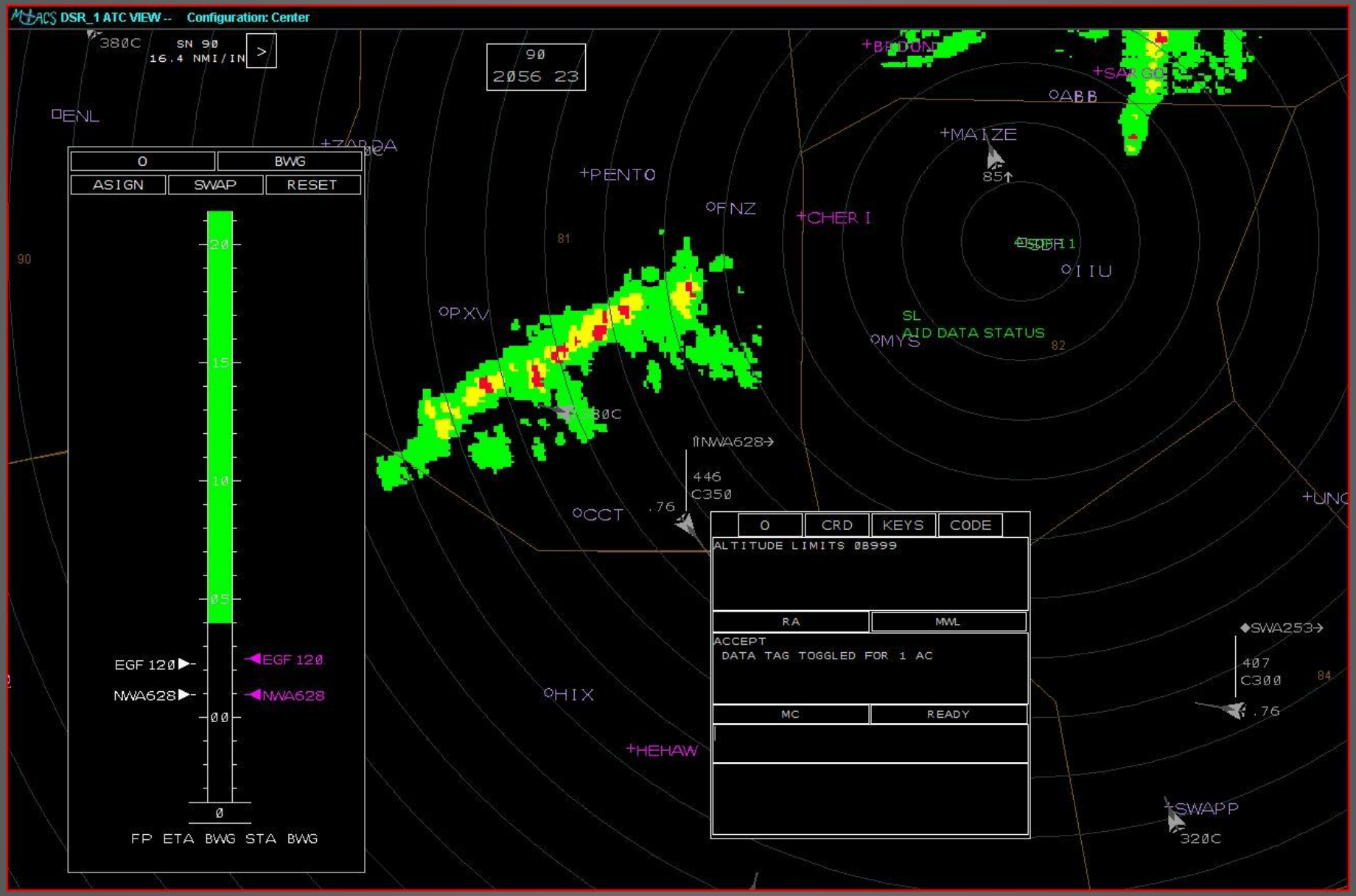
- Test in the same airspace and setup as the next experiment
- Check the debug logs after shakedowns
- A (very) Minimal Regression Test
  - test.AllTests.main(String[] arguments)
    - StabilitySensorTest may give false positives
  - Fire up Macs with a bunch of aircraft
    - Wait a little while
    - ENTER on an ac symbol, data tag should appear
    - PICK on the portal, trial plan should appear
    - Click-Move-Click or Drag a point on the trial plan
    - Type 'TT', trial plan should disappear
    - Click on call sign, filed route should appear
    - Type ZZZZ and filed route should disappear
- A true regression test for the integration branch is in work

Good Luck!

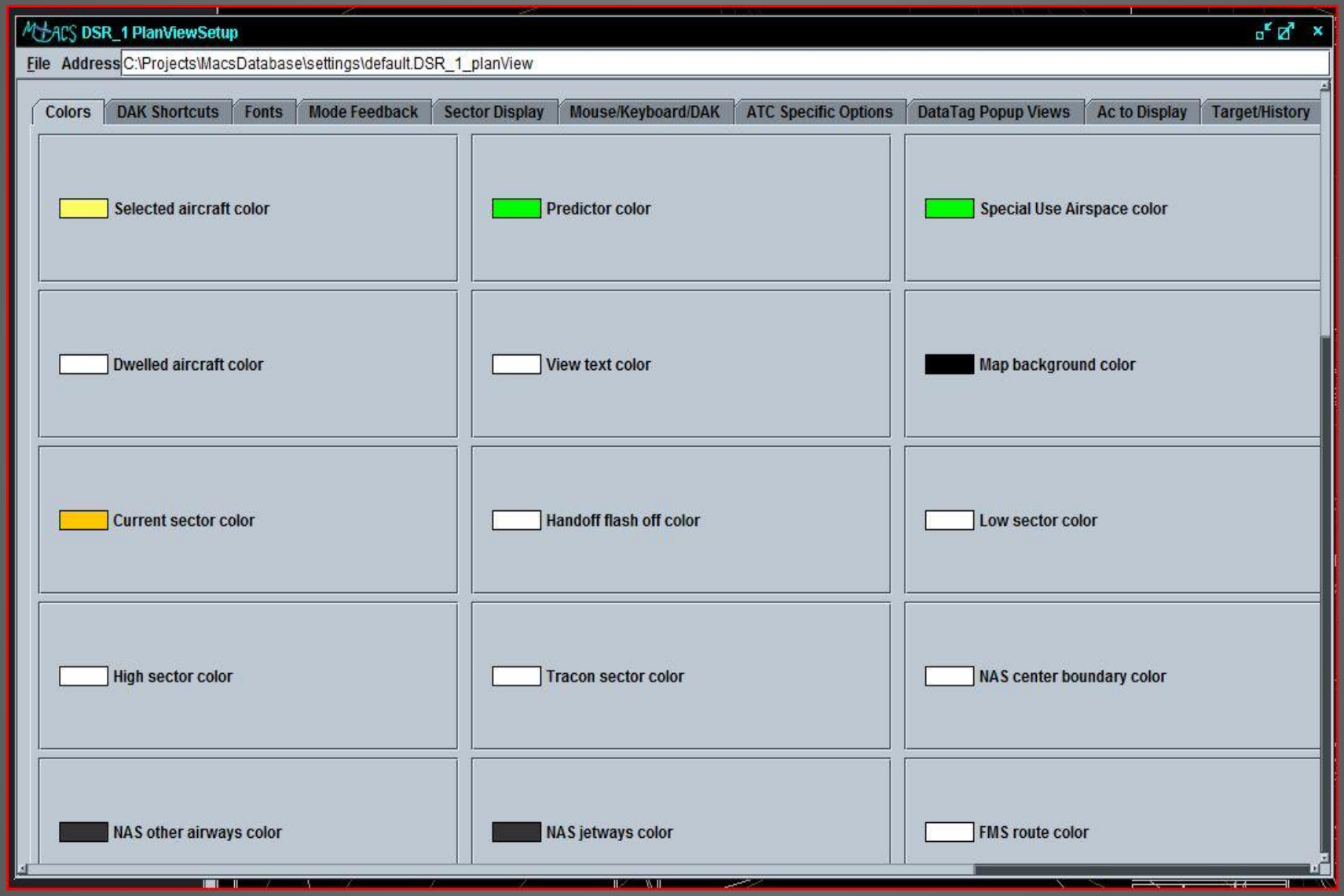
- Al Globus – aglobus@arc.nasa.gov, x3819
- Rick Jacoby – richard.h.jacoby@nasa.gov, x0023
- James Wong – james.k.wong@nasa.gov, x6313
- Vic Kelkar - vaibhav.kelkar@nasa.gov, x3238

Backup/additional information

DSR


DSR_1 ATC VIEW -- Configuration: Center
380C
SN 90
16.4 NMI/IN
90
2056 23
ENL
ZARDA
PENTO
FNZ
CHER I
ABB
MAIZE
85
PXV
MYS
AID DATA STATUS
IIU
NWA628
446
C350
CCT
.76
O
BWG
ASIGN
SWAP
RESET
EGF 120
NWA628
FP ETA BWG STA BWG
O
CRD
KEYS
CODE
ALTITUDE LIMITS 0B999
RA
MWL
ACCEPT
DATA TAG TOGGLED FOR 1 AC
MC
READY
HIX
HEHAW
SWA253
407
C300
SWAPP
320C

PlanViewSetupWindow



SectorPlanViewSetupWindow

MACS DSR_1 SectorPlanViewSetup

File Address C:\Projects\MacsDatabase\settings\default.DSR_1_sectorPlanView

AC Filter | Maps/Airways | Optional Views | Rng Rngs/Vectors | Shortcuts

View	Enable	Display	In Banner	Externalizable
DsrDcView	☑	☑	☑	☐
DsrCrdView	☑	☑	☑	☐
DsrTimeView	☑	☑	☐	☐
DsrBannerView	☑	☑	☐	☐
DsrConflictView	☑	☑	☑	☐
DsrD2View	☐	☐	☐	☐
DsrFrView	☑	☐	☐	☐
DSR Timeline TEST1	☐	☐	☐	☐
DSR CmdInputView	☑	☑	☑	☐
DsrControllerInfoView	☑	☑	☑	☐
DsrConfigView	☑	☐	☑	☐
DsrDlMenuView	☑	☑	☑	☐
DsrDlStatusView	☑	☑	☑	☐
DsrDlBannerView	☑	☑	☑	☐
RngReadView	☑	☐	☑	☐
ZoomView	☐	☐	☑	☐
AcFilterView	☑	☑	☑	☐
BoundaryView	☑	☐	☑	☐
RangeView	☑	☑	☑	☐

AtcDisplayObjects

- Package: displays.atcDisplayData
- One for each display characteristic (~100)
- Each ATC display has an AtcConfigMan that references the AtcDisplayData objects
- Object super-class hierarchy
  - AtcDisplayObject
    - AtcVisualObject
      - OptionalViewAdo
      - DisplayChar
      - SpacingAid
- Range, Keyboard, Handoff -- subclass AtcDisplayObject
- Leader, WayPoint, RangeRing -- subclass AtcVisualObject
- TimeLineView, CrdView -- subclass OptionalViewAdo
- TimelineChar, DataBlockChar -- subclass DisplayChar
- Cones, Halos -- subclass SpacingAid

Saving & Restoring AtcDisplayObjects

- Hierarchical saving and restoring
- Saving builds a String
  - Vector getData()
    - getCommonData() [name]
    - getVisualData() [display it]
    - getClassSpecificData() [min/max/current values]
- Restoring uses a string
  - setData(Vector String)
    - setCommonData()
    - setVisualData()
    - setClassSpecificData()
  - Removes Strings as it proceeds

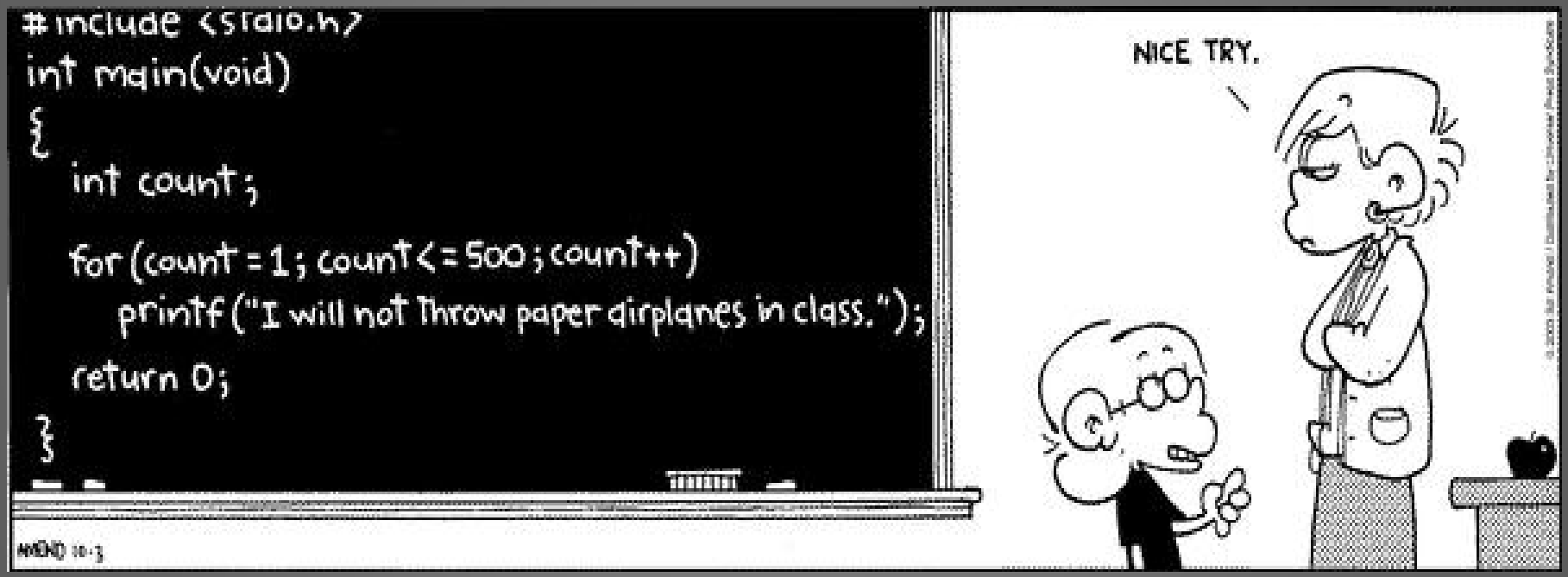
ATC Displays Class Hierarchy

- CommonWindow -- extends JInternalFrame
  - Screen info: sizing, scrolling, jpanel, tool bar. …
- CommonPlanViewWindow -- extends CommonWindow
  - Airspace info: sector lists, mouse in NM, PlanViewSetupWindow, SectorPlanViewSetupWindow, AtcConfigMan
- CommonAtcWindow -- extends CommonPlanViewWindow
  - ATC info: list of views, aircraft, cursors
  - OverPanel (Glass pane)
  - AtcMap (paintComponent, mouseListeners)
- DsrAtcWindow, StarsAtcWindow, TsdAtcWindow, Ocean21AtcWindow, EramAtcWindow -- extends CommonAtcWindow
  - Class specific methods

Views & OverPanel

- CommonAtcView
  - A view is the internal panel on an ATC display
  - JPanel
  - CommonAtcWindow has list of views
  - All views added to OverPanel
  - (ERAM views not yet a CommonAtcView)
- OverPanel
  - JPanel
  - setGlassPane(overPanel)
  - No layout manager
  - Updates views' position, visibility, visuals

Command Processing



Command Processing

- Command parts:
  - Keyword(s), parameter(s), aircraft(s)
  - QP J 5 UAL123
  - QP J 6 AAL456 DAL789

- Command status
  - AtcCmdIcd.java
    - enum CmdStatus
      - CMD_ACCEPT
      - CMD_REJECT
      - CMD_PARTIAL_ACCEPT_REJECT

Summary of Adding a New Command

- In displays.atc.AtcCmd, add enum
  - MY_CMD(“key words”, “methodName”,
    NumAcNeeded.xxx, minArgs, maxArgs,
    DcEvent)
  - See ML_MAN_ASSIGN for an example

- In displays.atc.AtcCommandProcessor, add a method to process the command
  - static public AtcCommandOutput methodName(
    AtcCommandInput ci)
  - See assignSta(AtcCommandInput ci) for an example

Adding the Enum to AtcCmd

- 5 command formats (constructor formats)
- “Best” format
  - Command name
  - Command keyword(s)
  - AtcCommandProcessor method
  - Number of aircraft needed
  - Minimum/maximum number or arguments
  - Data collection event
  - Optional: Window type [DSR, STARS, …]
- Example
  - DLSL ON
    - DLSL("DLSL", "dlStatusList", NumAcNeeded.ZERO, 1, 1, DcEvent.ATC_SET_DL_STATUS_LIST, WindowType.STARS)
  - QP C 6 AAL123 DAL456
    - KB_CONE("QP C", "cone", NumAcNeeded.ZERO_OR_MORE, 0, 1, DcEvent.ATC_CONE),
- Utility methods also in AtcCmd
  - acceptsMultipleAc()
  - getNumAcNeeded()
  - getCmdStr()

Command Processing Files

- Definitions
  - AtcCmd
  - AtcCmdIcd
- Processing
  - AtcCommandProcessor
  - DsrCommandProcessor
    - Used for all ATC windows
- Input/Output
  - Used by processing method
  - AtcCommandInput & AtcCommandOutput
    - AC list, parameter list, forced, CommonAtcWindow, status, original input
  - AtcCommandOutput
    - Accept & reject lists of AC

Processing a Command

- DsrCommandProcessor
  - All commands for all ATC display windows pass through here
  - Historically processed all commands (parse and process methods)
  - Uses utilities
    - parseCmd(…)
    - ArrayList<String> getAcFromInput(…)
    - AtcCommandInput createCommandInput(…)
    - checkForLocalCmd – debugging, symbolic arguments
  - executeAtcCommand(…)
    - Java reflection by looking for method name in AtcCommandProcessor
    - AtcCmdProcessor.execute(methodName, CI)
  - Still does many, some converted to “sliver” methods
    - return executeAtcCommand(inputCmdStr, "route", atcCmd, tokens, 0, Macs.INT_NOT_SET);

- AtcCommandProcessor
  - Add “process” method for new commands
  - Process methods
    - Input: AtcCommandInput
    - Output: AtcCommandOutput
  - Comment all the input syntaxes for each execute method
    - // AS R <scheduler> <HHMM> <HHMM>
    - // QP J <ac>
    - // QP J <radius> <ac> radius => 1.0 .. 9.9, 10 .. 30

Adding a Data Tag Item

- commonObjects.TagTextDescr
  - add field myField
  - either run common objects tool or fix up auto-generated methods
  - set in populateXXXX(arg) methods
- displays.datablock.DbIcd.java
  - add to end of DB_FIELD_NAME
  - add to end of TAG_EXAMPLE
- displays.dataBlock.DataTag
  - add TAG_MY_ITEM to static ints
  - set TAG_MY_ITEM in initiateTagItemId()
  - modifify DataTag.setTagText(TagTextDescr) to set tagDisplayText[TAG_MY_ITEM] from TagTextDescr.myField
- NOTE: there is a TagTextDescr.debugText that you may set freely