

**GSAW 2017**  
**March 13-16, 2017**  
**Renaissance Los Angeles Airport Hotel**  
**Session 4: Data Analytics**

# Creative Analytics of Mission Ops Event Messages

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# Events/Log Analysis - Theory

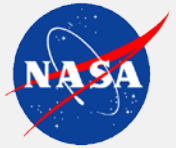
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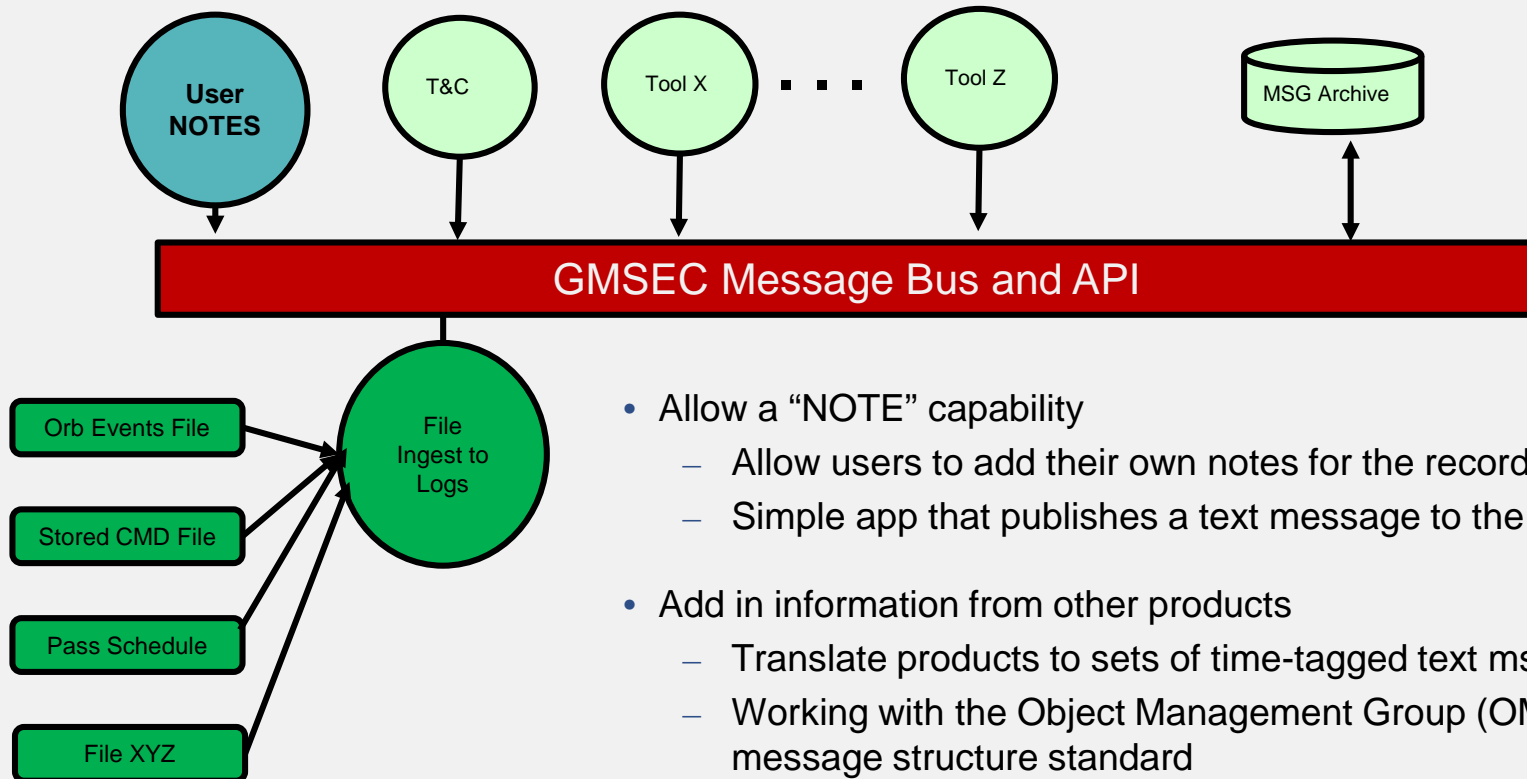
- 2016/101:13:34:05.34 ORB Entering Eclipse. Duration = 12:34.000
- Historically, we have put tremendous effort into processing and displaying housekeeping telemetry.
  - We convert it, combine it, limit-check it, plot it, and trend it. We even draw dials and thermometers.
- Events/Log messages have received much less attention
  - Once a message scrolls off the screen, we often never see it again
  - Limited use for automation and for notifying team of issues via email or texting
  - Logs are often in each local system and not viewed together
  - Perl scripts sometimes developed to help analyze the logs
  - It is the logs that know when commands were resent, when there were data drop outs or system failures, when people log on and off, and much much more.
- What could we do better?
  - Bring together the logs of multiple systems to increase situational awareness
  - Express many of our non-telemetry items as event/log messages
  - Create new display and analysis tools to provide powerful new situational awareness and operations support capabilities



# First, let's collect the information



- Combine existing logs
  - With Goddard Mission Services Evolution Center (GMSEC) open pub/sub architecture, components each publish their event messages and a single archive can be created



**Great News: Now we have lots and lots of time-tagged text data to work with!**



# Now we have a problem!

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- Some missions may have 50,000 or more messages per day!
- With new levels of automation, there may not even be any operators on-console to watch displays
- As we move towards constellations and enterprise systems, we will be mixing satellites in the same logs
- **Out of sight → Out of mind**

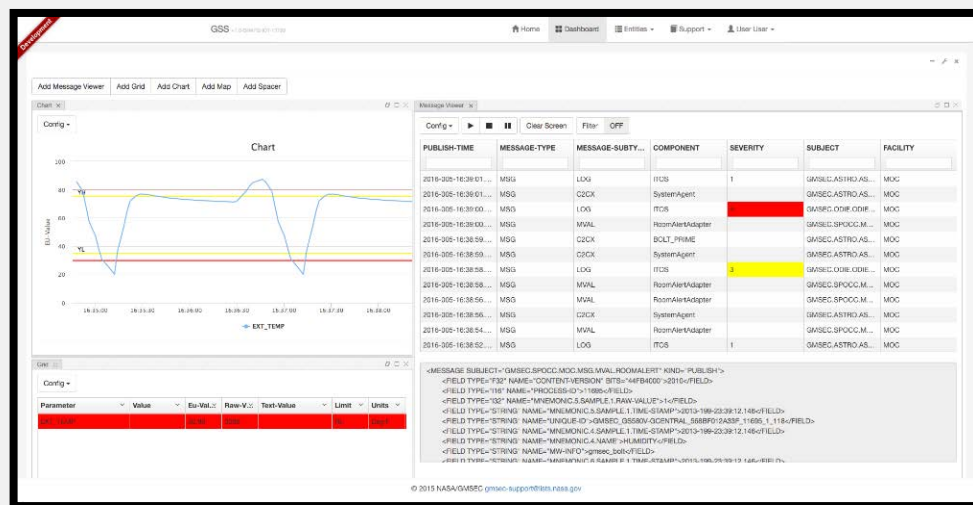
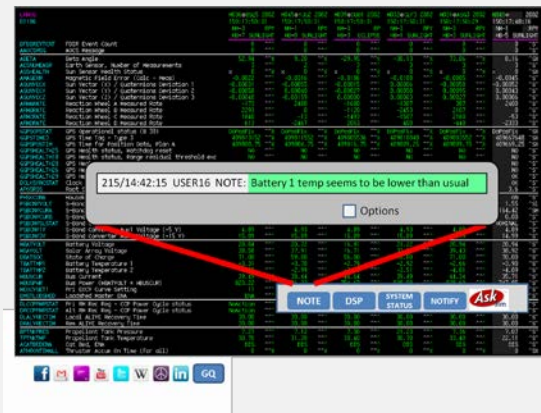
**If we have a huge message log, but nobody can use it,  
do we even have a message log?**



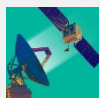
# How can we display 1,000's of messages?



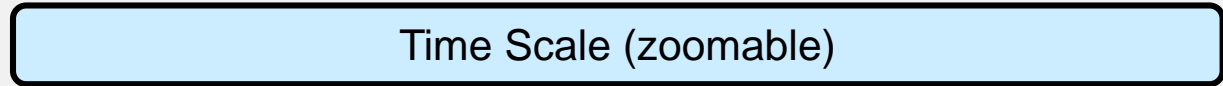
- Enhanced message log display – similar to today's capabilities
  - Simplify the dynamic filters for the users
  - Enable color coding of message fields, not just of entire line



- “Ticks and Bars” Display
  - User defines the lines of the display
  - TICK, Title = “COMMANDS SENT”, Find = “/CMD”
    - Display will show a small mark on a time scale for each command sent
  - BAR, Title = “ECLIPSE”, Start = “Eclipse Entry”, End = “Eclipse exit”
    - Display will show a bar on a time scale depicting eclipse period
  - Zoomable time scale; event message viewer at bottom of display



# Ticks and Bars Display Capability



CMDS Sent



Alarms



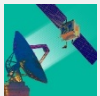
Sched. Passes



Actual Passes



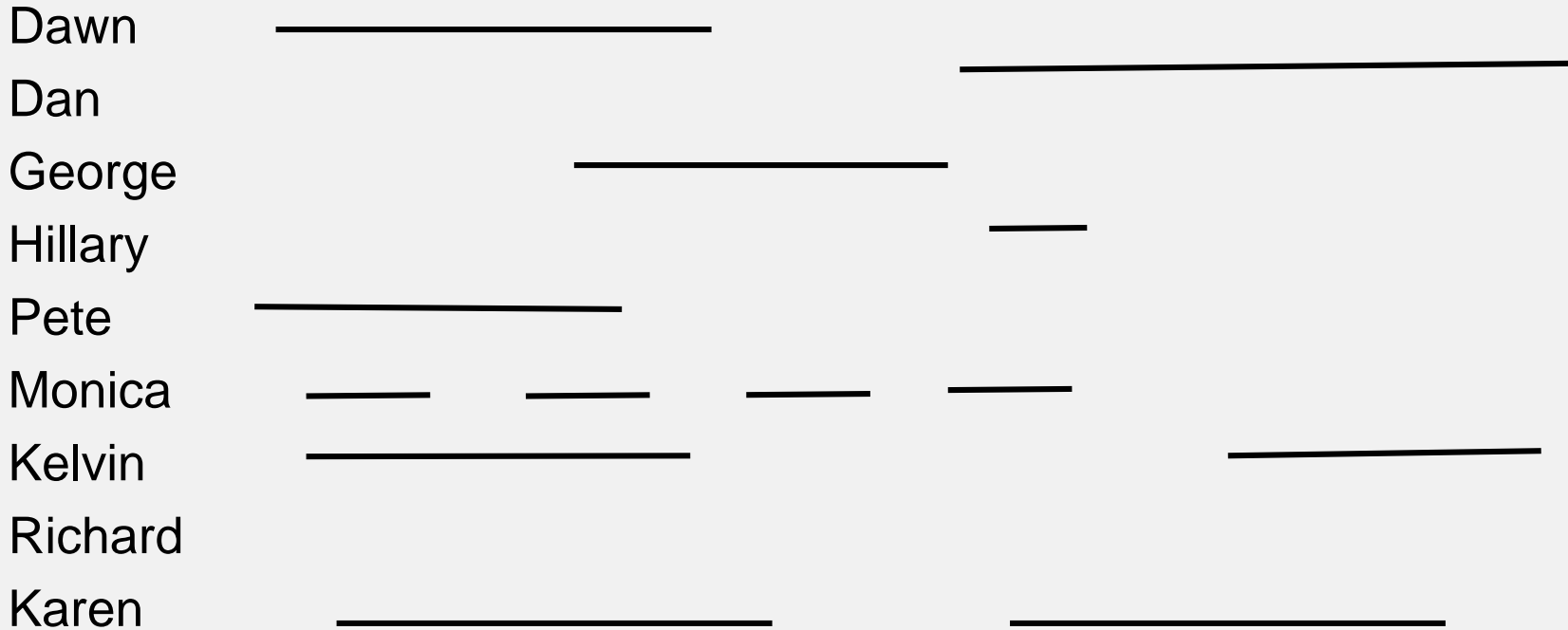
Event/Log Messages (time tags, flags, source, text) Scrollable within above time range



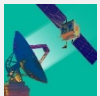
# Ticks and Bars Display – Team Staffing



Time Scale (zoomable)



Event/Log Messages (time tags, flags, source, text) Scrollable within above time range



# What can we learn from 1,000's of messages?

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- “Ask Jim” – Query Capabilities
  - Structured language to allow for smart searching of the events logs.
  - Key words or phrases: How many . . . , When did . . . , For how long, ...
  - Key time words: TODAY, YESTERDAY, etc.
  - Response could be an English sentence response or a set of messages.
- User specifies enough information to find the needed messages
  - Time span, text-match information
- Tool can FIND, COUNT and COMPUTE-DURATION
- Could have FAQs and user-defined keywords to simplify user input
- Sample Queries
  - QUESTION: How many commands did we send today?
  - RESPONSE: As of 18:30 today, 237 commands have been sent
  - QUESTION: When did we send command HEATER\_1A\_ON?
  - RESPONSE: Command HEATER\_1A\_ON was last sent on Day 63 at 13:42:05

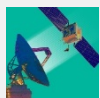
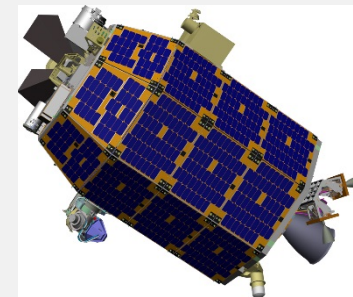


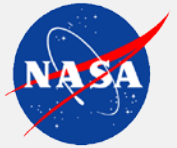


# Let's get more advanced



- Event-based automation (already available)
- More sophisticated queries
  - Compound queries
  - Ability to exclude certain messages
- Auto-generation of shift/status reports based on event message analysis
- Text-Based Data Analytics
  - Discover/learn trends or sequence “signatures”
  - Cross-vehicle assessment
- Move to natural language interface
  - Allow broader search ability
  - Support voice recognition
- Create a Ops Assistant
  - Imagine an Amazon Echo for each ops position
  - What would the conversation be?
- Access to telemetry values and event messages could be seamless, allowing queries, reports, and displays to easily intermix the two
  - Time frame on plots could be based on query to event log (ie. Plot parameters x, y, and z for the last orbit, or for when John was logged on yesterday.





- We think that the set of events/log message enhancements will provide powerful capabilities for the mission user regardless of Agency or type of mission
- Placing an emphasis on non-telemetry analysis opens up a new area of data mining, analytics and tool development – we think the users will help identify even more functions
- This is a great set of applications for mission operations, especially using the GMSEC open architecture– the tools will work regardless of what other products are part of the configuration; it works by monitoring traffic on the bus; and is not reliant on any specific vendor products.



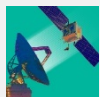
# Over the Horizon . . .



Could combine event message analysis and analytics with personal “Amazon Echo-style” assistant with virtual reality view of the vehicle showing sun angles/shadows, instrument pointing, temperature readings, etc.



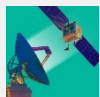
Clipart courtesy of pixabay.com public domain images.





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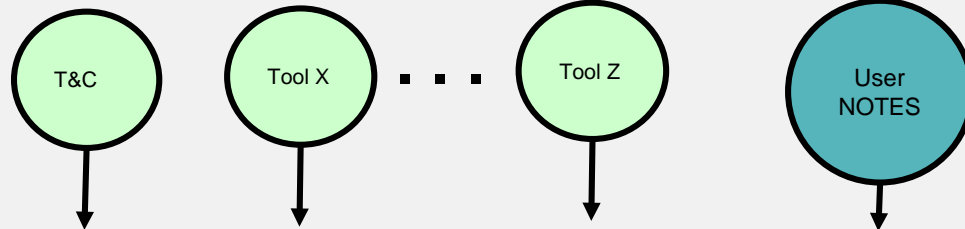
# Questions?



# GMSEC Log Msg Approach



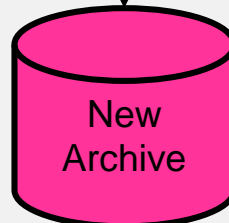
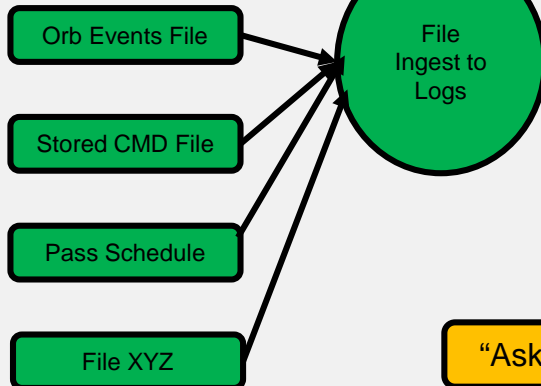
**Current:** Each component writes log messages to the bus.



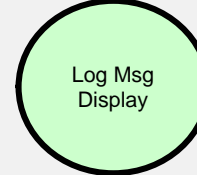
**New Feature:** Users can make log entries



Applications subscribe to the messages



Upgraded archive to enhance speed, capacity, and queries.

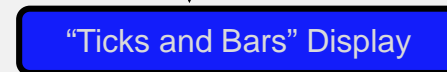


Web-based log displays provide:

1. Simplified Access
2. Better color-coding
3. Better filters and sorts

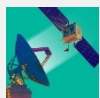


Structured English query of the events log file.



User-defined graphical time-based display of selected events.

Converting file contents to event messages creates a single integrated log to help increase situational awareness.



# If I could really change things . . .

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- I would make event messages more like e-mail
  - We learned long ago that simply having a time, a source and some flags, and some text [subject] was not enough to convey a message
  - Imagine if we could have optional body text to explain a problem in detail
    - Like the body of email messages
    - Could provide details on a parameter when it goes out of limits
    - Could include the full text of a rule that is violated
  - Imagine if we could have attachments
    - Could capture a screen image when a problem is noted
    - Could include a script that might help get out of a problem

