



National Aeronautics and Space
Administration
Jet Propulsion Laboratory
California Institute of Technology

The Value of SysML Modeling During System Operations: A Case Study



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DAWN



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- Introduction/Problem Statement
- The Model
- Advantages/Disadvantages
- Summary

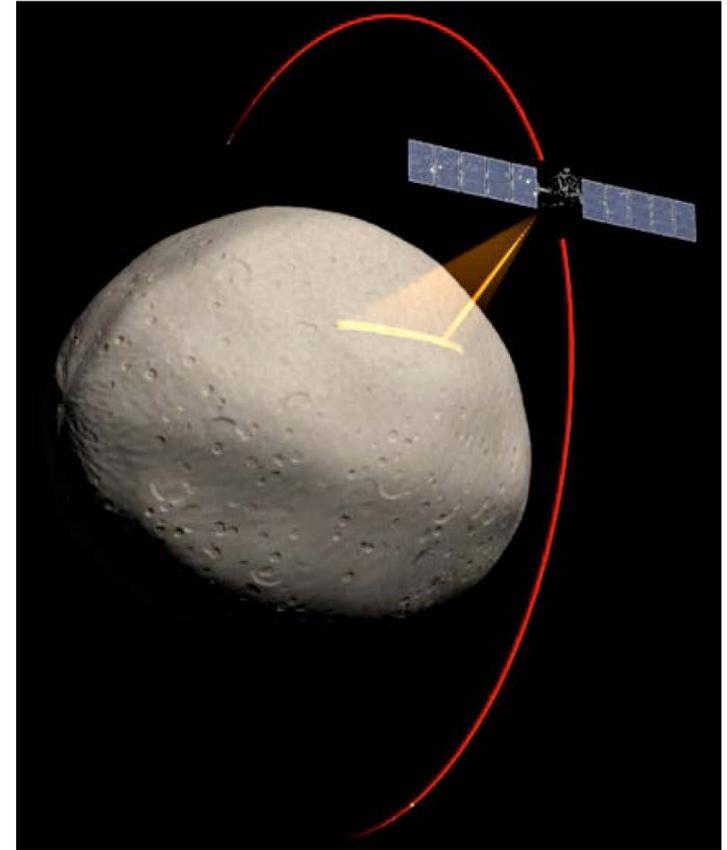


Problem Statement

- Since spacecraft Ground Data Systems (GDSs) are never truly finished, the need to upgrade them during mission operations while maintaining usability is an issue.
- Inheritance of a GDS by new engineers is also a common occurrence, since those people that develop GDSs often leave the project before operations are complete.

Introduction of Dawn

- Spacecraft launched in 2007
- First probe to enter orbit around a body in the main asteroid belt
 - Vesta encounter July 2011 to September 2012
- Currently in cruise phase, arrive at protoplanet Ceres in early 2015
- Paper written leading up to and during Vesta encounter
 - Team had a few years of operations experience to base paper on
 - Lessons learned can be applied to Ceres encounter



Credit: NASA/JPL-Caltech/UCLA/McREL

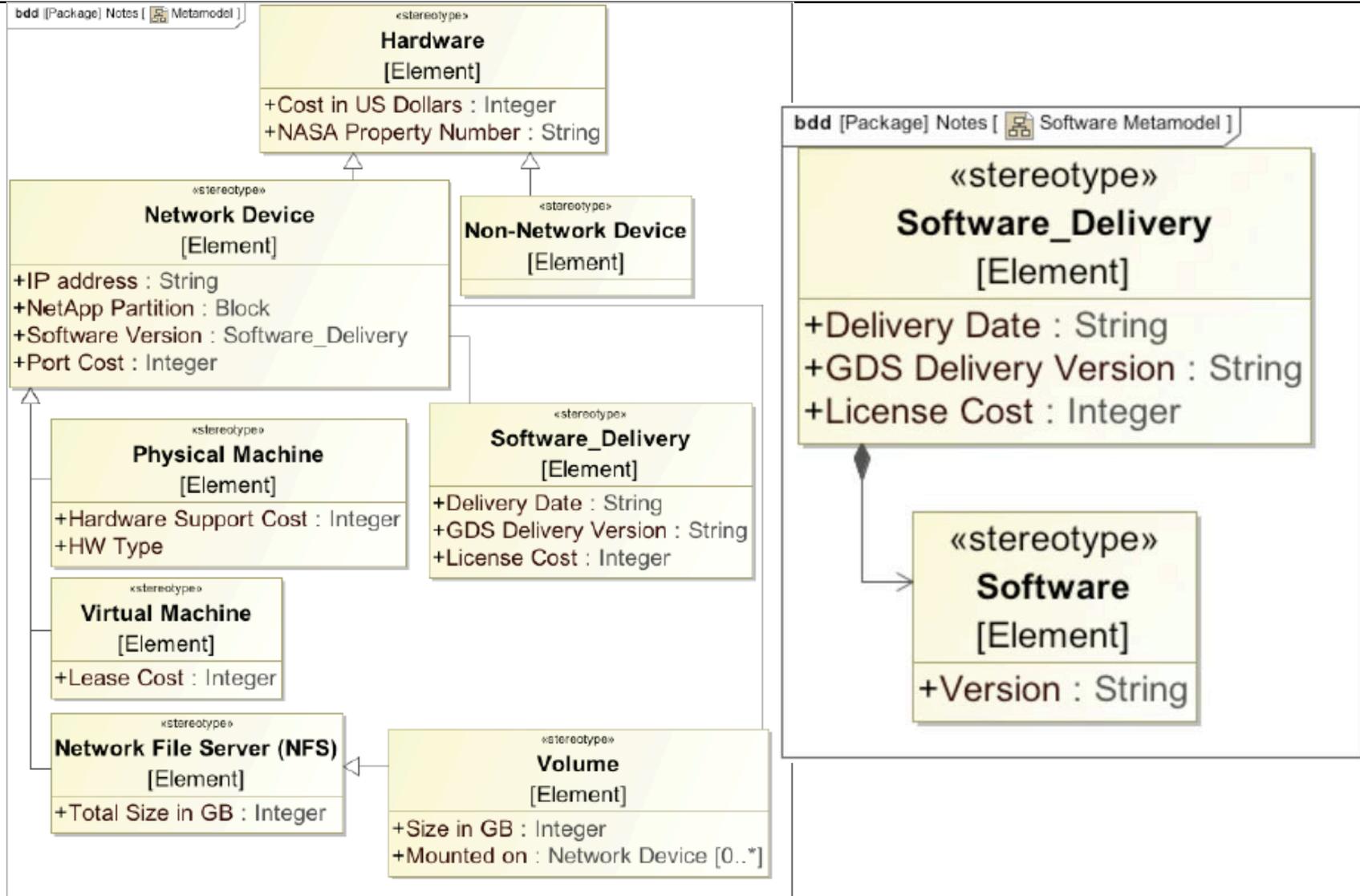


Introduction of Solution

- Dawn's GDS was chosen as a case study
- In order to better understand the system, we undertook a case study to model a currently operating GDS for several reasons:
 - To better understand the system we inherited
 - To gain insight into what would happen to the system if different upgrade scenarios were attempted (without any actual risk to the system)
 - Assuming that the model is first validated against the actual system through testing



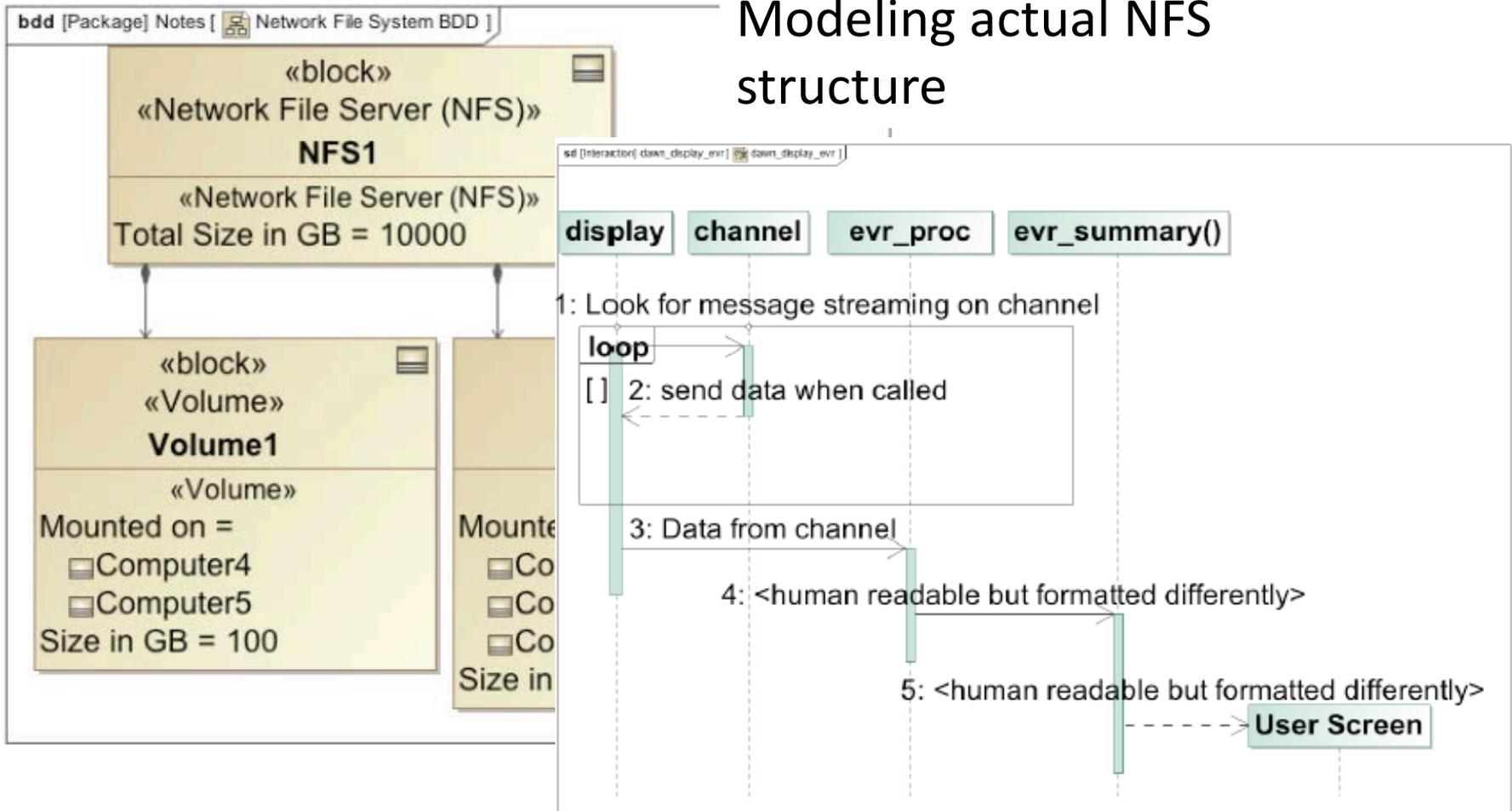
Creating a Model Framework



Dawn

NFS Mapping and Software Sequence Diagrams

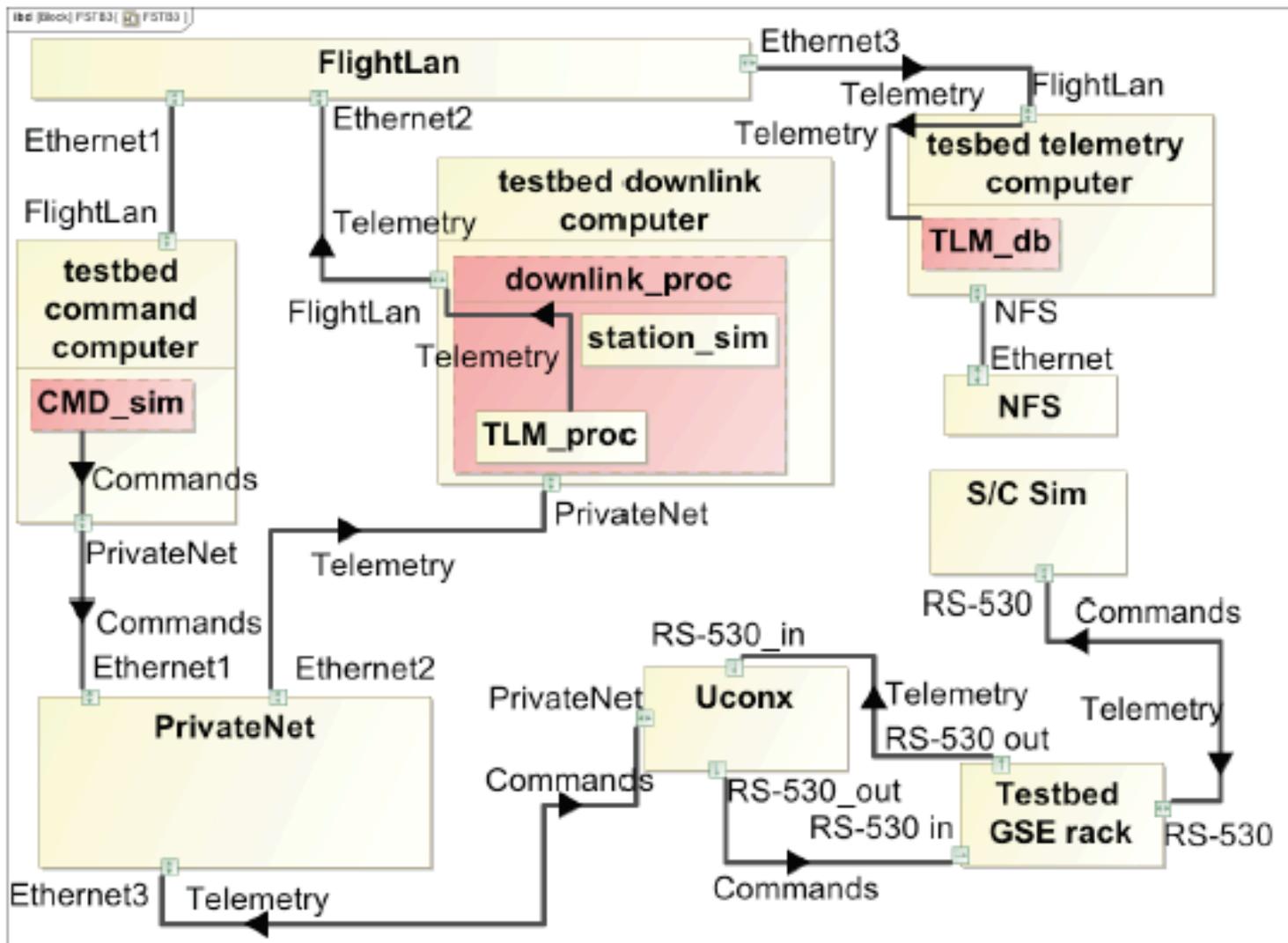
Modeling actual NFS structure



Making troublesome pieces of software easier to understand

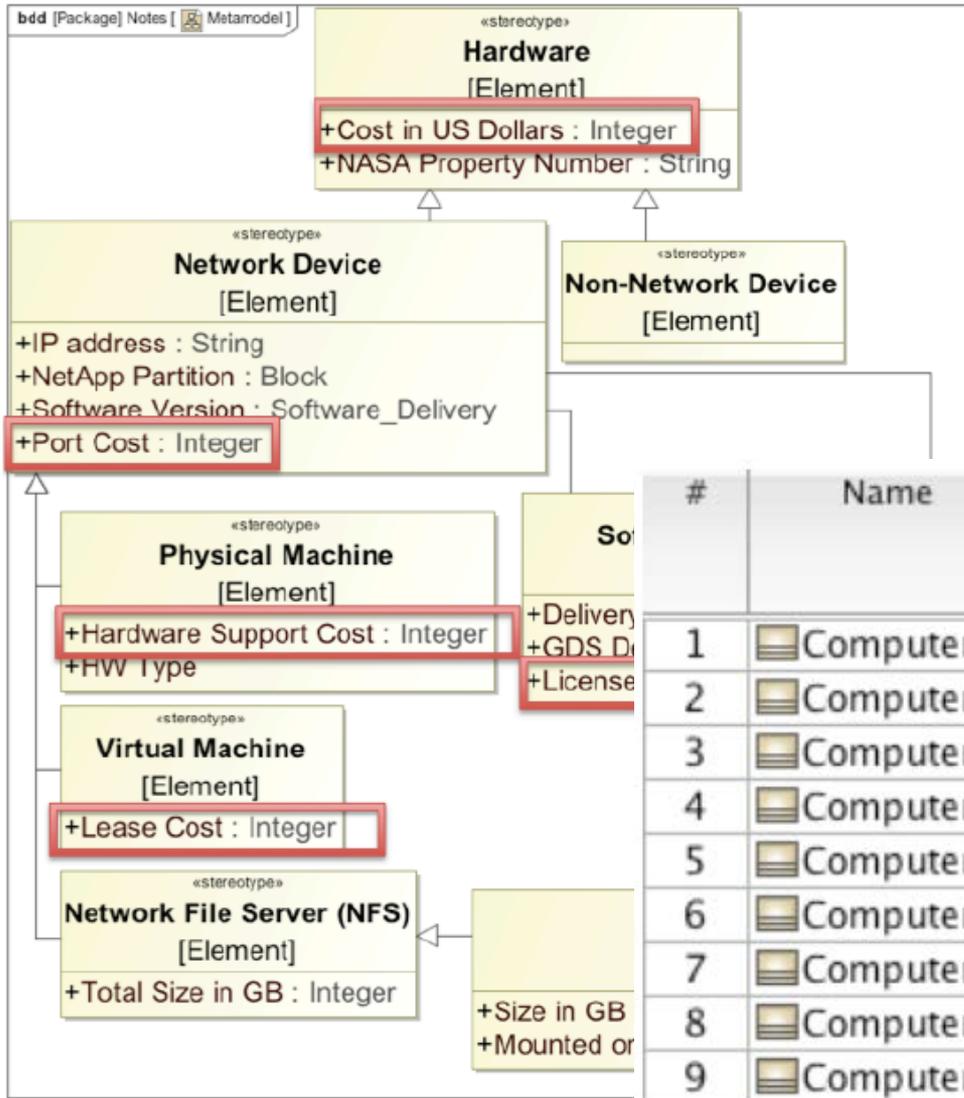


Testbed Diagram





Dawn Scripts



- Cost Rollup
 - Licenses
 - Hardware Support
 - VM lease
 - Port Cost
- Machine Information

#	Name	IP address	Cost in US Dollars	NASA Property Number
1	Computer9	123.123.123.120	1	NASA1
2	Computer8	123.123.123.121	23	NASA2
3	Computer7	123.123.123.122	45	NASA3
4	Computer6	123.123.123.123	54	NASA4
5	Computer5	123.123.123.124	5	NASA5
6	Computer4	123.123.123.125	54454	NASA6
7	Computer3	123.123.123.126	3	NASA7
8	Computer2	123.123.123.127	454	NASA8
9	Computer1	123.123.123.128	32	NASA9

- **Easier to manage complexity**
 - Software functionality
 - Testbeds
 - Cost and other rollup scripts
- **Enabled clear thinking/planning**
 - Provided insight into an inherited GDS
- **Answered previously “difficult-to-answer” questions and prompted new ones**



Disadvantages

- Startup work necessary to create and validate model
 - Difficulties in modeling a system that was inherited
 - Team didn't know all that it didn't know
- Understanding scope of what to model (given time and resources) is difficult to know at the beginning of the task
 - The more you know, the more you want more



Summary

- Case study proved that there is value in starting a model of an inherited system to:
 - Manage complexity
 - Force clear and logical thinking
 - Understand new things about the system
- Starting the model earlier in the mission's life cycle would have been beneficial.
 - Scope was an issue when being done ex post facto and with limited resources
 - Some unknowns were unknown



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Questions?