Turning the Digital Thread into Reality

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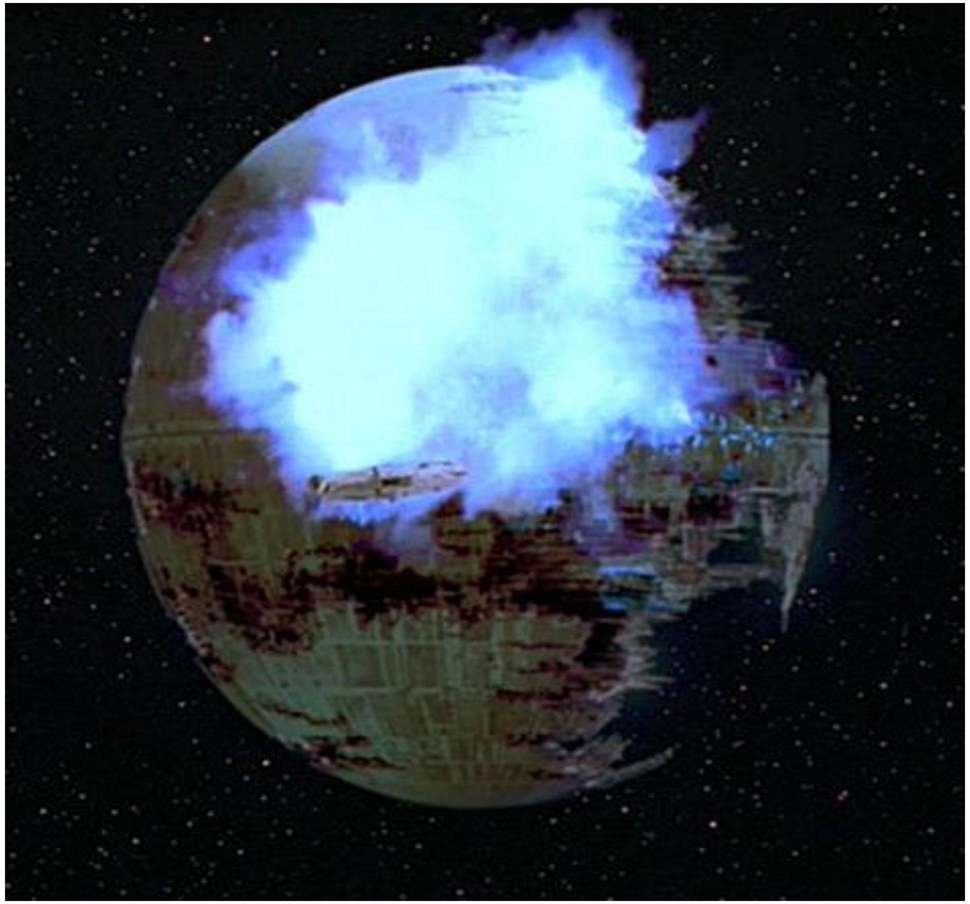
Agenda

- What are some of the major hurtles in making the digital thread a reality?
- Don’t we something like this already?
- Why do we want to create this “thread?”
- What’s really missing?
- What are we doing to overcome these problems?

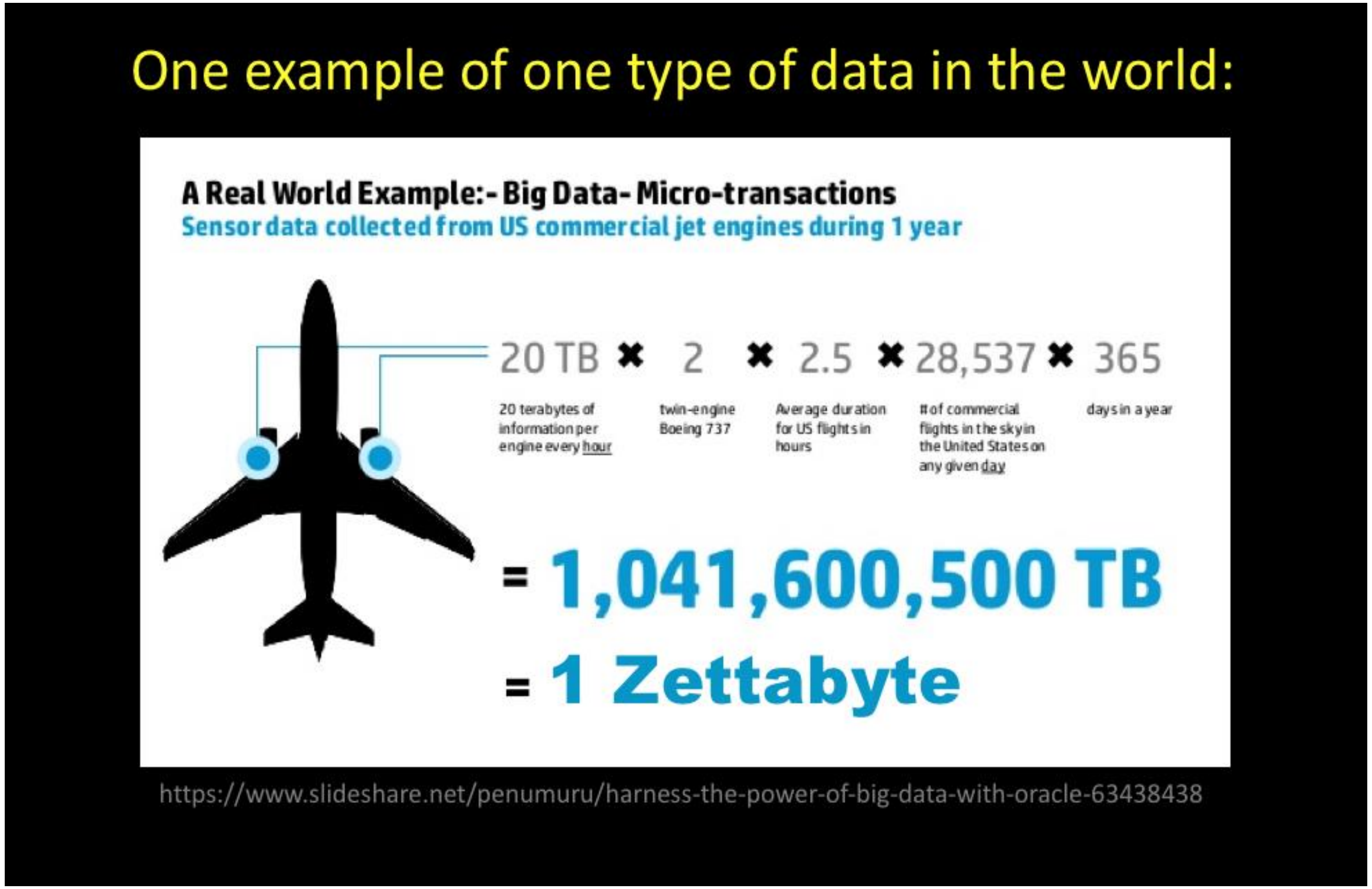
What are some of the major hurtles in making the digital thread a reality?

- Tool interoperability
- Security
- Scalability



Scalability Problem

- Today, complexity is going out of sight
- We no longer talk about Gigabytes of information, its now Zettabytes (1×10^{21} bytes)
- How can we deal with this much data?
- Do we really need all this data?



Slide from "Using Analytics to Predict and to Change the Future" presentation by Dr. Kirk Borne, BAH

Other Concerns

- Tool interoperability
- Security
- Scalability
- Intellectual Property
- Cost
- “Rice Bowls”

Is it really even desirable?

Don’t We Do Something Like this Already?

- We have been creating physics-based models of systems for decades
- Many of those models have been coupled to CAD/CAM systems
- The gaps between tools are used as “inspection points” for analysis
    - Is that bad or good?

Why Do We Want to Create this “Thread?”

- We think there will be significant saving accrued by having a seamless abstraction of an entire system
  - We have seen how the automobile manufacturers have gone down this path
  - The question is, “Are we making the same kind of product and incrementally improving it, as they do in the automotive world?
- We will clearly save time and money if we can more easily move information between tools

What’s Really Missing?

- Need methods to capture and visualize tremendous amounts of information
- Massive storage and retrieval of information
- Need not only all the technical readouts, but also the programmatic information
- Capability to move data around easily, between applications
- A language that enables decomposition and abstraction
  - A systems engineering language, not a software engineering language

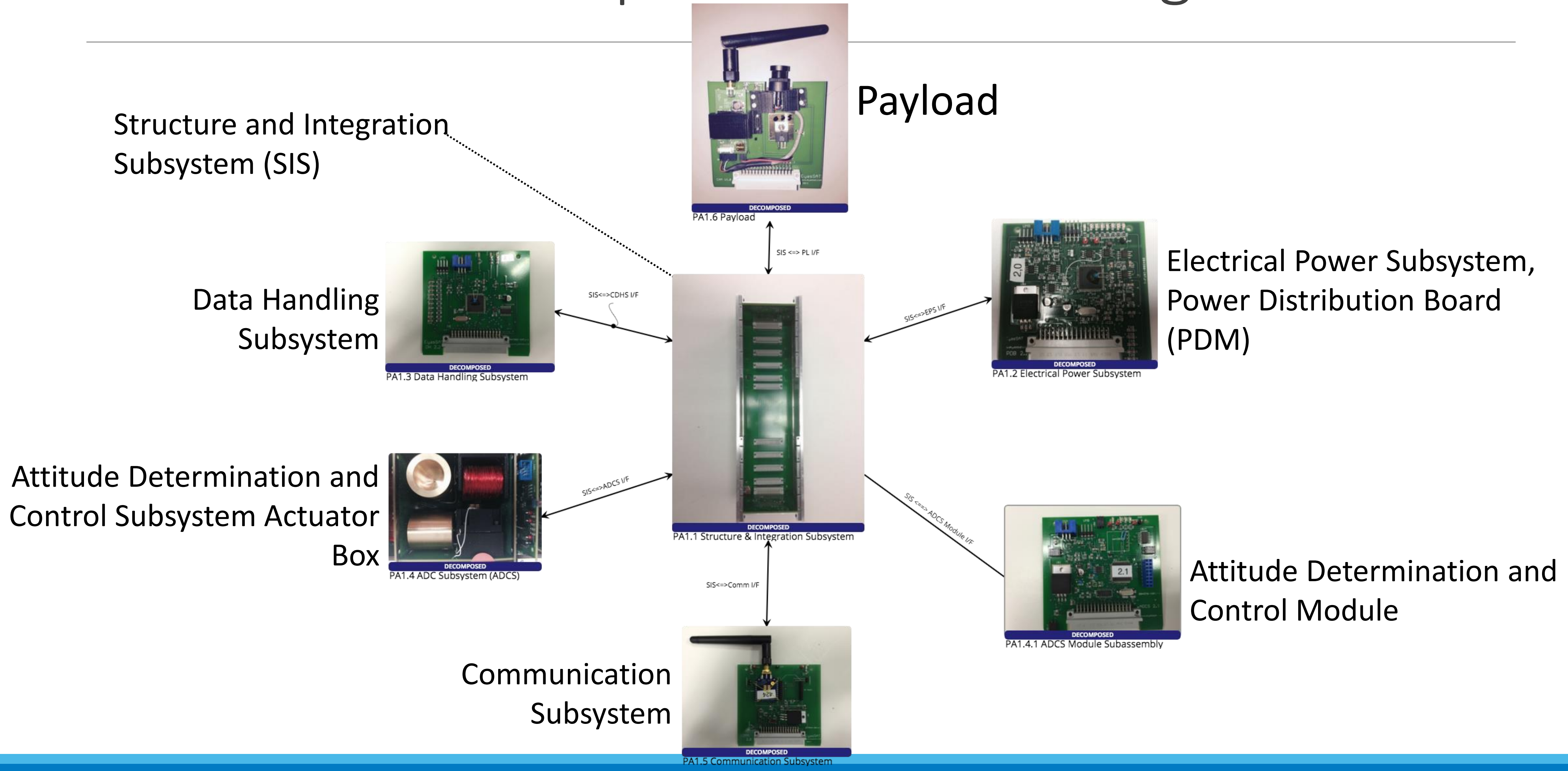
What Are We Doing to Overcome these Problems?

- Tool interoperability problems can be reduced by merging functionality into a common tool or tool set
  - SPEC has done this on the SE level with Innoslate®
  - Use of APIs can reduce the interoperability problem, if we have a common, generalized ontology to map tool data together (LML can provide this)
- Scalability, Security and IP problems can be resolved by continuing to partition the problem through decomposition
  - But this means that the databases at each level of decomposition must be able to interoperate (see bullet 1 above)
- Explore hardware-in-the-loop simulations, not just software

Example: NanoMET

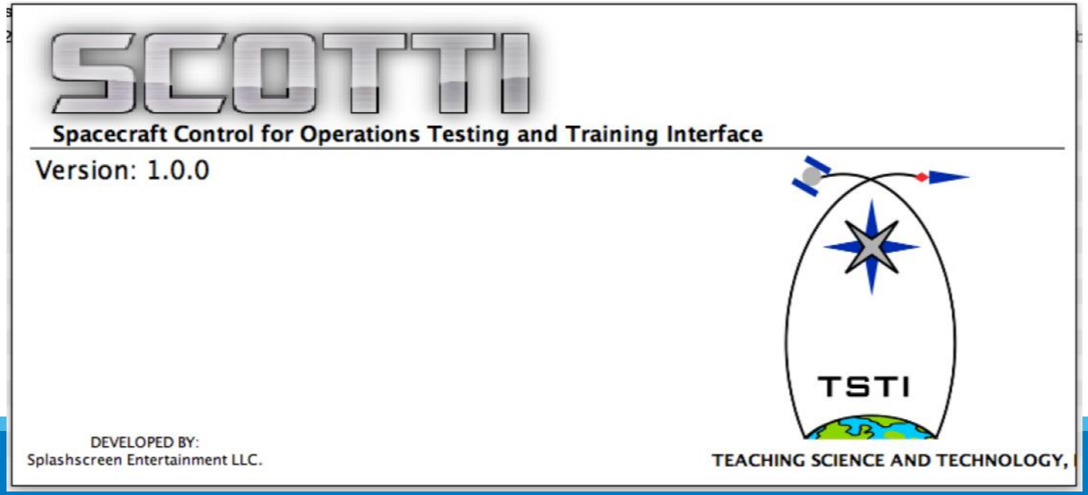
- NanoMet is hypothetical end-to-end systems engineering and project management case study designed for the education and training of space professionals
- NanoMet "spacecraft" are desktop training tools based on the EyasSAT3 (ES3) educational satellite bus
- All ES3 is "ITAR-free" and is not space qualified or qualifiable
- For the purpose of education and training, NanoMet is treated as a "real" space mission with representative systems engineering and project management artifacts and associated rigor

NanoMET Spacecraft Asset Diagram



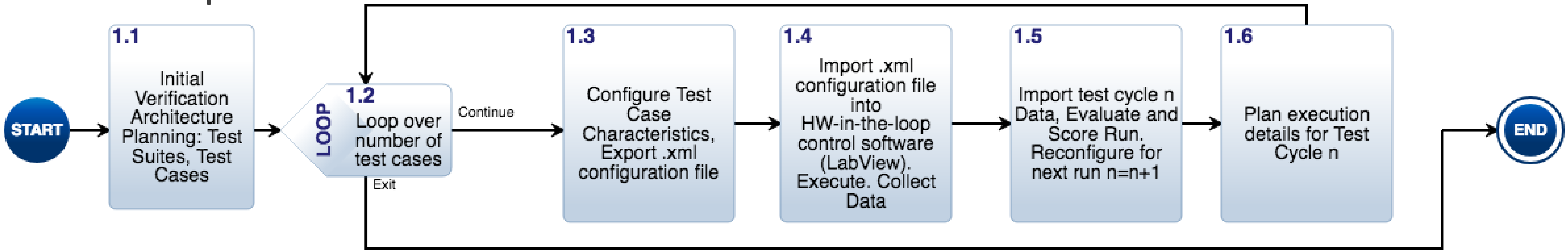
Spacecraft Control and Operations Testing and Training Interface (SCOTTI)

- SCOTTI is a versatile, LabView-based interface that provides a point and click graphics user interface (GUI) for all ES3/NanoMet lab and “operational” activities
- Provides insight into packet communication protocols (future A331 or SP200 lesson)
- Provides for real-time or Pass Planning execute-at-Time-X commands



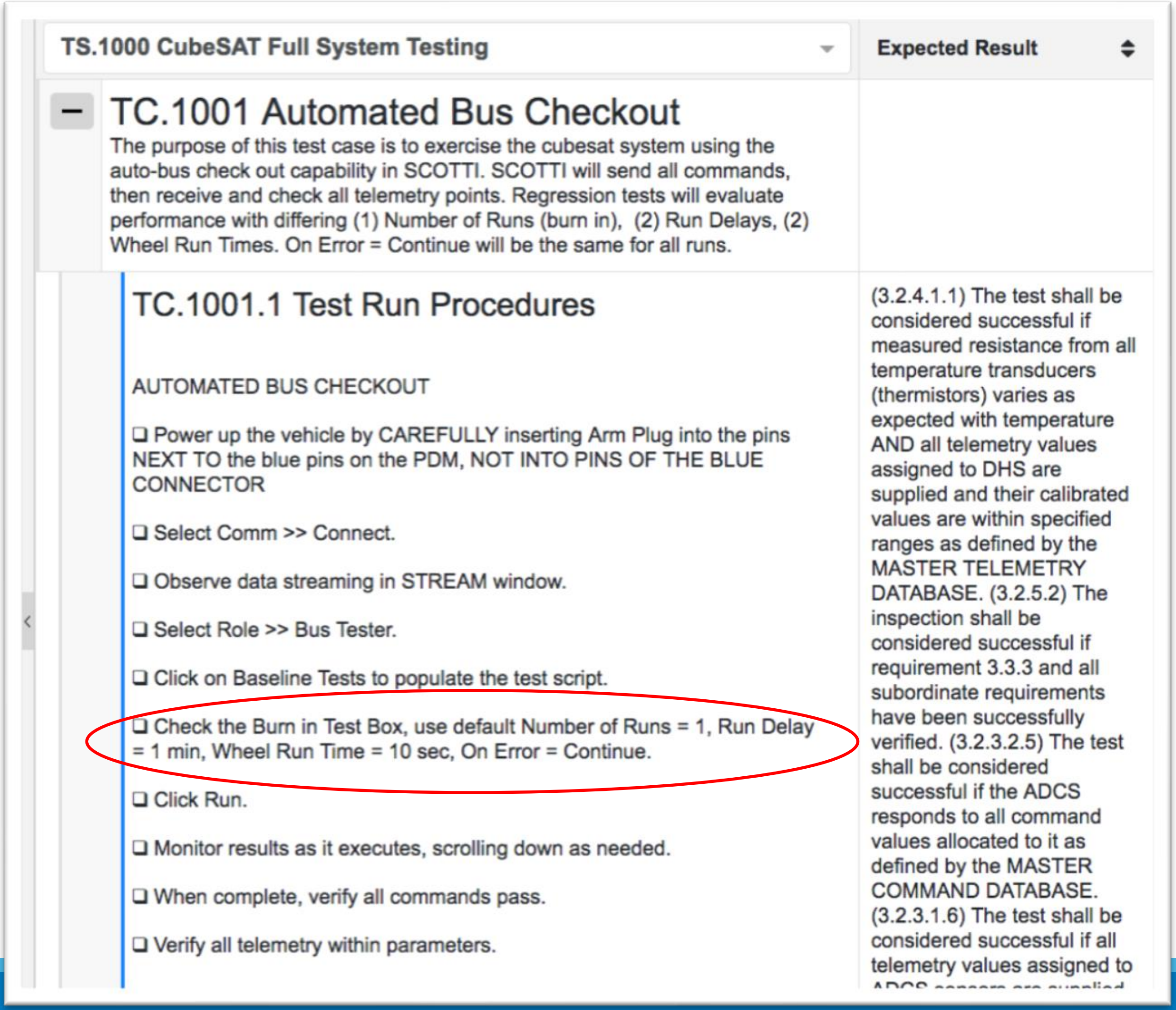
A Verification Round-trip Example

- Use Innoslate® to setup tests and record results
- Export Innoslate® XML to LabView "SCOTTI"
  - adding import capability to LabView took only a few hours
- Execute test cycle using LabView
- Import results to Innoslate
- Repeat



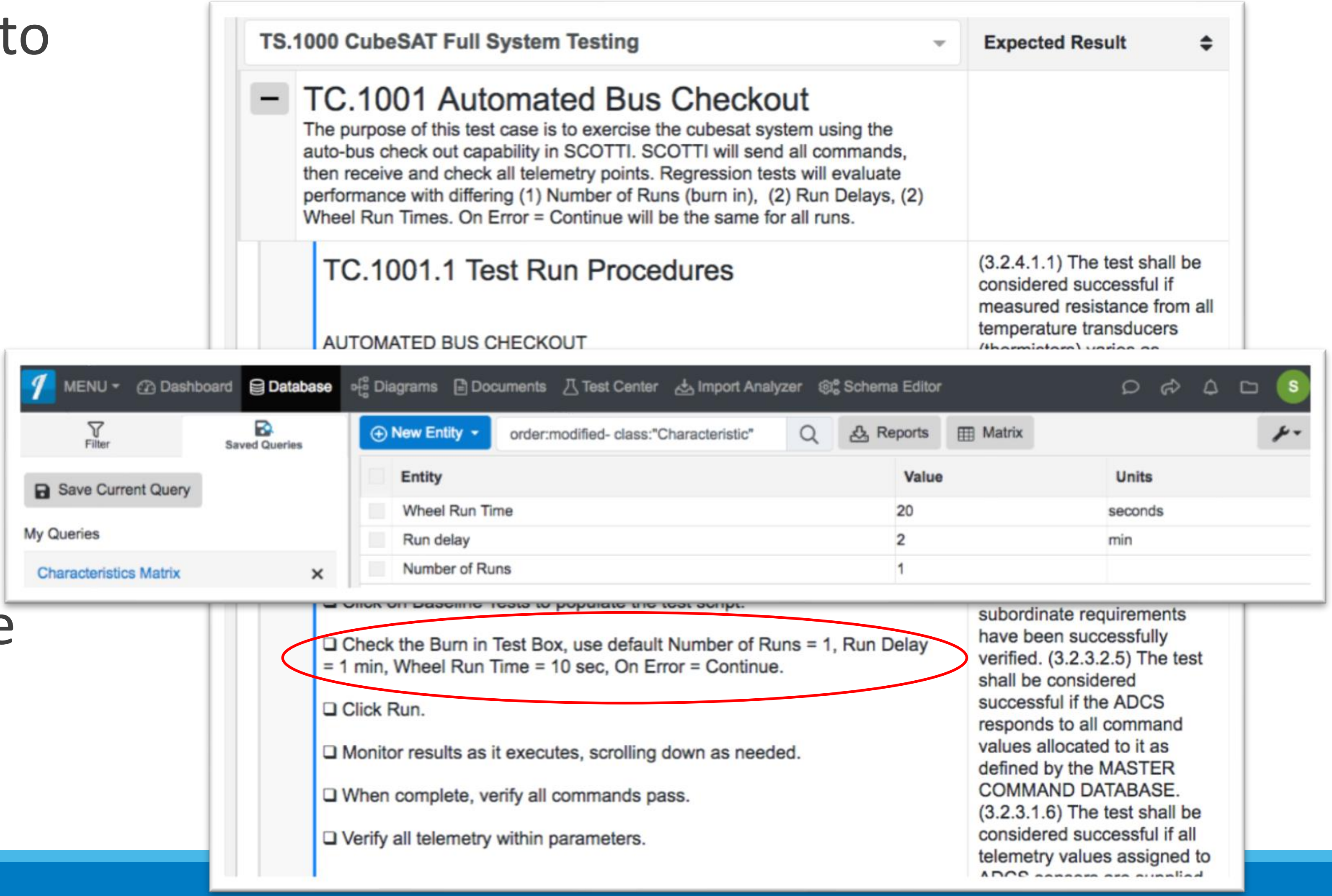
1.1 Initial Verification Planning

- Test Center provides means to create test cases and test suites
- The parameters we want to vary are also captured as Characteristics



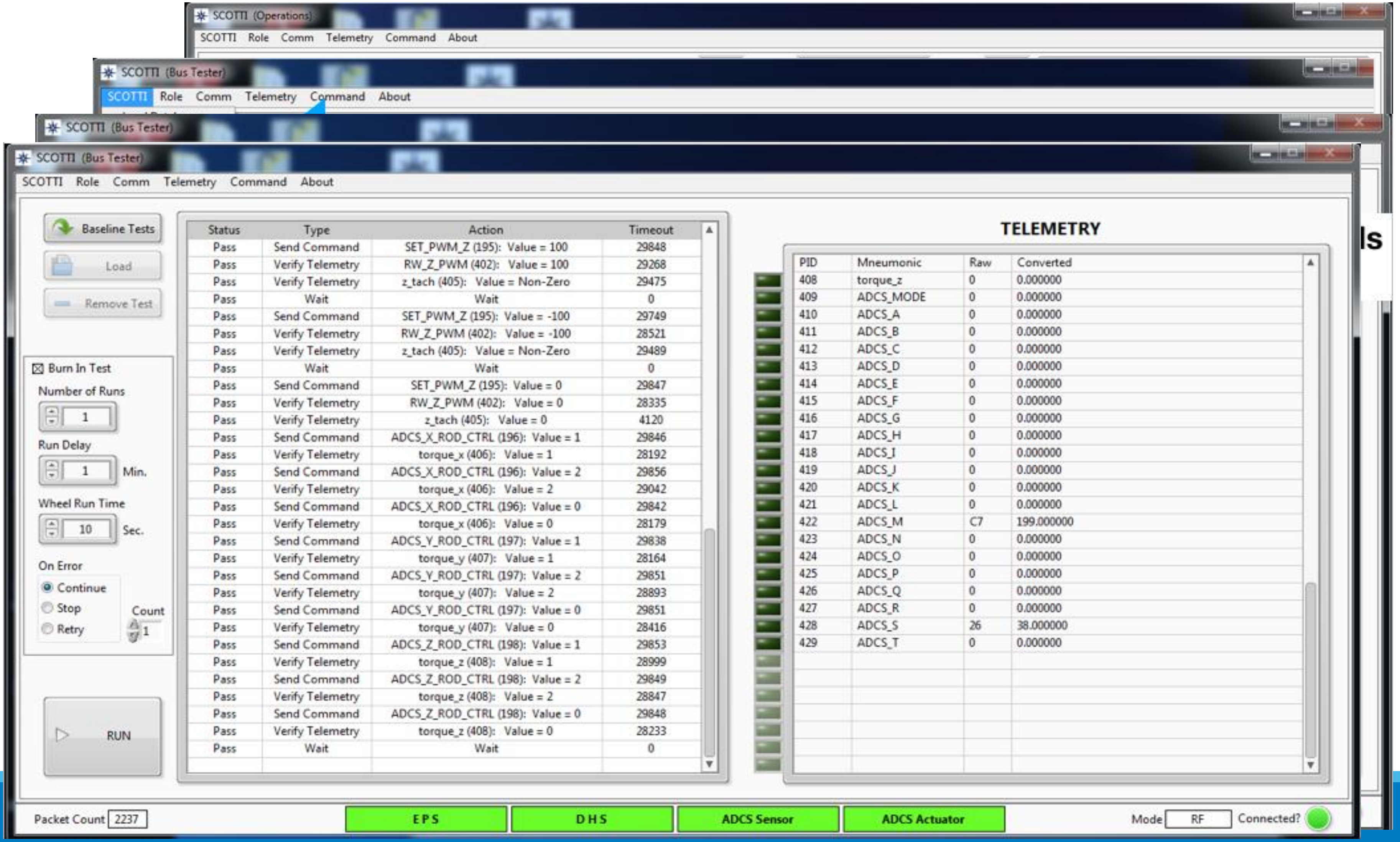
1.3 Configure Test Case Characteristics

- Test Center provides means to create test cases and test suites
- The parameters we want to vary are also captured as Characteristics
- We change those Characteristics to reflect the test case we want to execute in Database View
- Export XML



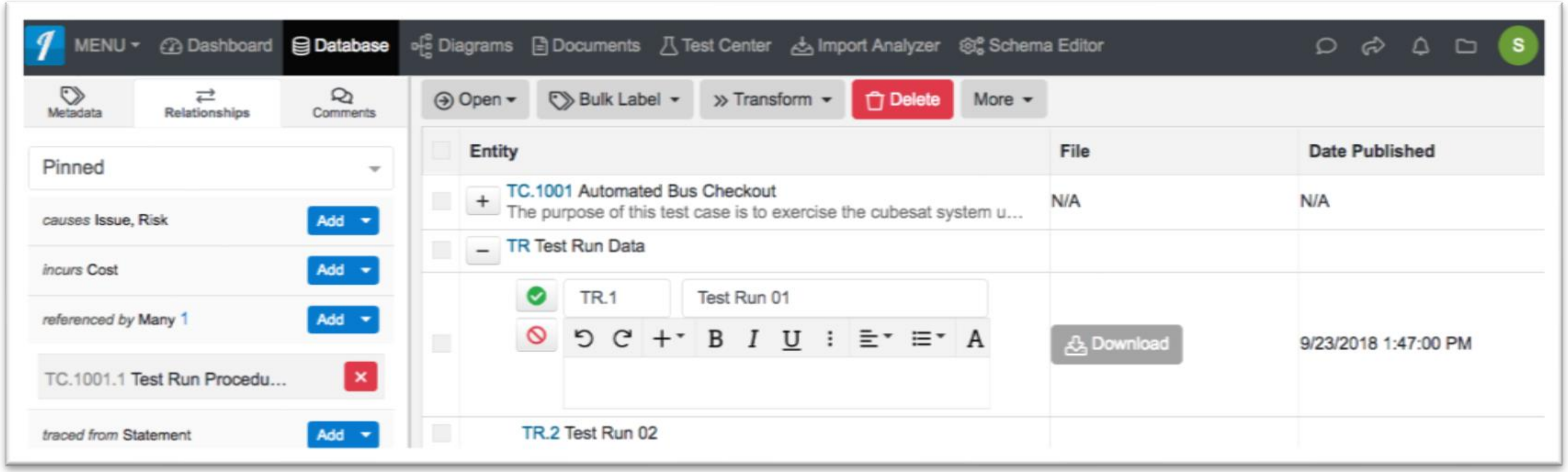
1.4 Import XML into LabView

- Import XML into SCOTTI
- Execute Test via SCOTTI
- Collect Data



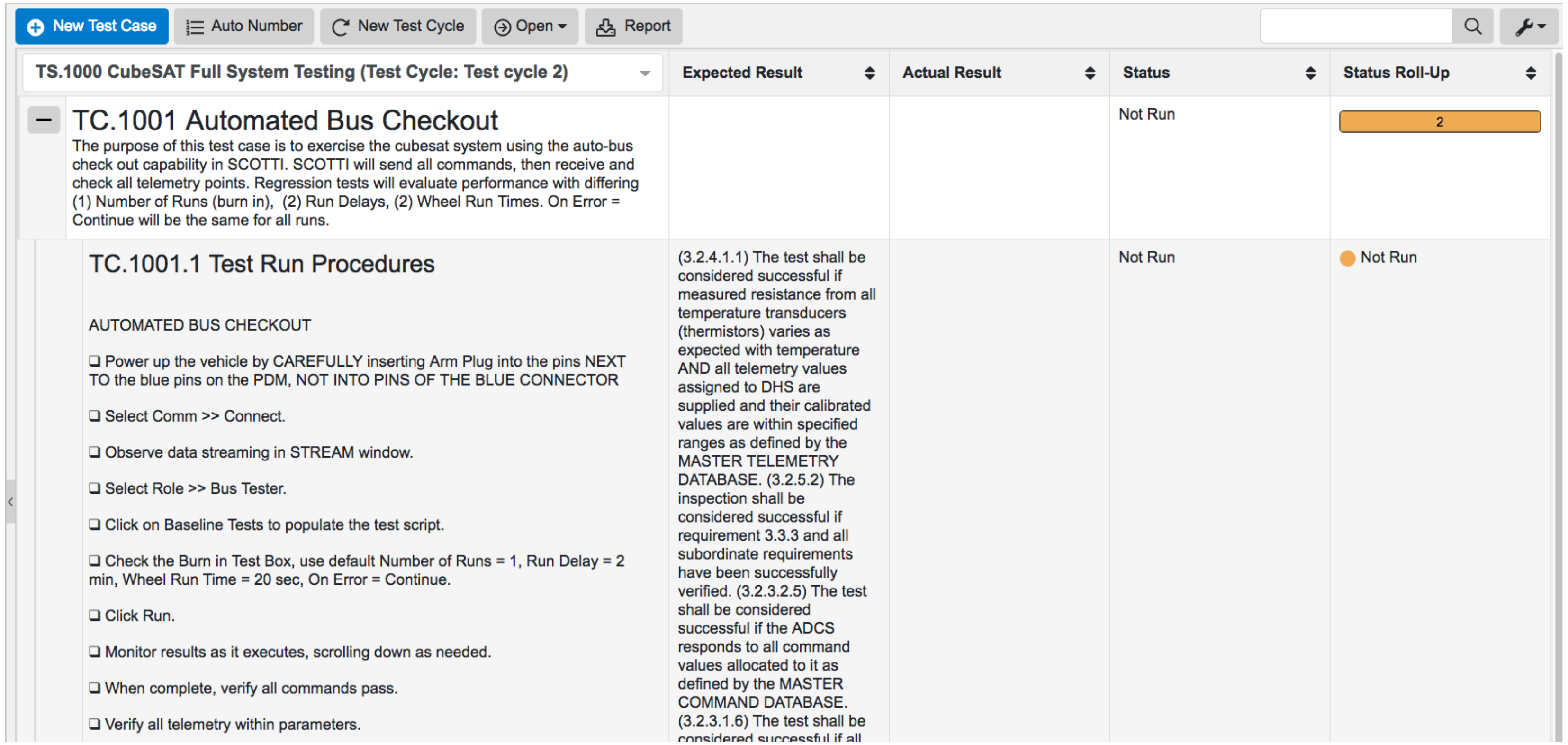
1.5 Import Test Results and Score

- Capture data files as Artifacts in Innoslate®
- Add any notes or date/times for the execution
- Relate to specific tests or identify any Issues or Risks associated with the test



1.6 Configure for Next Test Cycle

- New Test Cycle builds on previous work creating a new baseline
- Repeat process until all configurations have been tested



Next Steps

- This process can be fully automated by using Java or REST APIs, but that would be up to the organization
- Many engineers would prefer to run their own tests and vary the parameters as needed when they don't see the need to continue a particular path
- This approach can be generalized to apply to many other typical tasks in the Digital Engineering process
- We plan to continue this development for DoD and other customers