Key Ground System Architectural Issues

Data Accountability

* Unique data product identifier that travels round-trip
  - Originates with user request
  - Accompanies data request via uplink
  - Preserved through data generator(s)
  - Accompanies data returned via downlink
  - Preserved throughout ground data processing pipeline
  - Final product matched to request

* Cooperating databases of accountability status to answer queries
  - "Where's my data?"
  - "Why does it look like this?"
  - "Is that all there is?"
  - "Can the gaps in my image be filled?"
  - "What were the processing parameters used on my data?"
Key Ground System Architectural Issues

Flight-Ground coordination

* Flight and Ground Systems are cooperating parts of a single Flight-Ground System

* Derive both flight and ground software from the same database
  - Command parameters
  - Telemetry channels
  - Flight/Ground SW Configuration parameters

* Flight and Ground use each other’s tools to develop software

* Test as you fly
  - Use Ground System to test Flight System pre-launch, and vice versa
  - Requires an integrated test schedule (difficult across multiple organizations)

* CM both Flight and Ground software together
  - Rapid turnaround is necessary during development
Key Ground System Architectural Issues

Integrating with legacy systems

* Decide what to keep and what to replace
  - Keep: well-maintained, highly valued by users
  - Discard or Replace: bloated, obsolete, arcane, ugly

* Understand architecture of legacy systems
  - Avoids unnecessary re-invention
  - Helps to know how to cleave along fault lines

* Multiple development organizations adds to lead time
  - Up to 1.5 years from release of new OS to deployment of new GDS
    OS → 3rd Party COTS → Multi-Mission Infrastructure → Mission Specific Adaptation → User Configuration
  - Complicates scheduling of dev/integrate/test/install cycles

* "Software reuse without contracts is sheer folly" - Bertrand Meyer
Thoughts on “Architecture”

* Best viewed in hindsight
  - "Architecture is what you wish you had, but never have time for"

* System Architecture: includes people, holistic, globally optimized
  - Any system is also a subsystem, any subsystem is also a system
    Ground System is part of a Flight-Ground System
    Flight-Ground System is part of a Multi-Mission System

* Software Architecture: design patterns, frameworks, ...
  - Good substitute for a system architecture
  - S/W can accommodate any architectural concept (n-tiered, m-layered,..)

* Scale-dependent
  - Small = limited use, limited time frame, simple single-point design
  - Medium = single-purpose, multi-user, design for change
  - Large = multi-purpose, multi-decade, user-configurable

* Best if an architect owns it
Success Factors

A Good Architecture ...
accommodates or redefines the management structure
has an architect
is scaled appropriately for its context
has the Ground as part of a Flight-Ground architecture
strikes a balance between automation and operations
optimizes across hardware, software, people, cost, risk
contributes to overall mission success
has longevity, can evolve
survives a "good enough" implementation

A Bad Architecture ...
ignores or is driven by the existing management structure
is developed by committee, or happens by accident
is too simple or too grand for the real world
treats the Ground as the only "System"
uses AI where humans would be better, or vice versa
focuses on software only (or people, or hardware, or...)
focuses on one phase of mission (e.g. getting to launch)
becomes obsolete quickly, too rigid
requires an "all-or-nothing" implementation (monolithic)

A Good Architect ...
"feels the pain" of the developers, testers, and users
maintains a constant vision
communicates to developers and users in their language
refines architecture with top-down & bottom-up iterations
is a generalist with expertise that is both broad and deep
understands the importance of system engineering
knows that "can be done" does not mean "should be done"

A Bad Architect ...
lives in an ivory tower
has no vision, or often changes it
cannot translate the vision into vernacular
fails to adjust for practicalities
is a specialist in one discipline or paradigm
thinks that having a good architecture is sufficient
insists on using the newest fad just because

A Good Engineer...
understands the importance of the architectural plan
can overcome a flawed architecture

A Bad Engineer...
equates "system engineering" to "system architecture"
cannot fill in the missing pieces during implementation