Implementing the Complete Digital Thread

Cory Kinsel
Engineer Systems
Northrop Grumman
Background

• Member of MBSE Solutions Team
  • Supported 6+ Programs/Teams
• Trained Engineers in MBSE Methodology and Tools
• 4+ years of Modeling and Simulation Experience
• B.S. AAE from Purdue University

Cory Kinsel, Systems Engineer
Northrop Grumman Innovation Systems
Hey, Can you get me this data?

Sure!

I’ve finally got the data requested! Time to write the report.

Well, that took forever…

Here’s the approved report containing the data requested!

Thanks!

© 2019 Northrop Grumman. All Rights Reserved.
Reality: Silos are NOT going away

<table>
<thead>
<tr>
<th>Connotations</th>
<th>Possibilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Separate Methods</td>
<td>• Understood Unified Method</td>
</tr>
<tr>
<td>• Lacking Communication</td>
<td>• Instant Notification of Results</td>
</tr>
<tr>
<td>• Minimal Collaboration</td>
<td>• Leverage Skills and Knowledge</td>
</tr>
</tbody>
</table>

Challenge: Integrating Silos into a Cohesive Team
Method

Global Product Data Interoperability Summit | 2019

Digital Engineering Strategy

1. Formalize Development, Integration and Use of Models
2. Provide an Authoritative Source of Truth
3. Incorporate Technological Innovation
4. Establish Infrastructure and Environments
5. Transform Culture / Workforce
Sources of Truth
Minimize Time to Answer

Accessibility to Data
Standardize Views
### Collaboration is Team-Centric

<table>
<thead>
<tr>
<th>States and modes</th>
<th>Description</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SysSpec-3.1</strong></td>
<td>The system shall have non-operational states for maintenance and diagnostic testing.</td>
<td>Functional</td>
</tr>
<tr>
<td><strong>SysSpec-3.1.1</strong></td>
<td>Non-Operational States</td>
<td>Functional</td>
</tr>
<tr>
<td><strong>SysSpec-3.1.2</strong></td>
<td>Operational States</td>
<td>Functional</td>
</tr>
<tr>
<td><strong>SysSpec-3.1.3</strong></td>
<td>Ready for Launch Time</td>
<td>Performance</td>
</tr>
<tr>
<td></td>
<td>The system shall transition from Standby to Ready for Launch in less than 120 seconds.</td>
<td>Performance</td>
</tr>
</tbody>
</table>
How do you turn silos into an efficient team?
The Digital Thread
Completing the Circle

Global Product Data Interoperability Summit | 2019

Diagram showing relationships between system, verification results, and requirements.
<table>
<thead>
<tr>
<th></th>
<th>1990’s</th>
<th>2010’s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Email</td>
<td>Install and Manage Thunderbird</td>
<td>Log into Gmail</td>
</tr>
<tr>
<td>Office Productivity</td>
<td>Go buy and install MS Office</td>
<td>Log into Google Docs</td>
</tr>
<tr>
<td>Media Consumption</td>
<td>Install WinAmp</td>
<td>Log into Spotify</td>
</tr>
<tr>
<td>Gaming</td>
<td>Go buy and install Baldur’s Gate</td>
<td>Log into Farmville</td>
</tr>
</tbody>
</table>
Software as a Service

WolframAlpha® computational intelligence.

\[ x^2 + y^2 = 9 \]

Geometric figure:
circle

Implicit plot:

Alternate form:
\[ x^2 + y^2 - 9 = 0 \]
Benefits of SaaS/MaaS + DevOps

Global Product Data Interoperability Summit | 2019

• Provide on-demand access to models
  • Model suppliers own the source
  • Model suppliers set the bounding box for model accuracy

• Access Control
  • Owned by model suppliers
  • Model Visibility

• Model Releases
  • Supplier controls approved version
  • Quality control for models

• Access > Distribution
  • Maintain IP
  • Ensures Consistent Results
MaaS

Global Product Data Interoperability Summit | 2019

Run Model

Input Parameters
payload mass
range ...

Black Box Model Automation

Output Parameters
Isp
inert mass ...

- Any analytic model can go in the Black Box
- Models run on remote server
- Access models over network
DevOps

Global Product Data Interoperability Summit | 2019

Code → Build → Test → Release/Deploy
Olympic Games

Olympic Games are the most important international multi-sport event, organized by the international Olympic Committee (IOC) since 1896. The games feature sports from around the world, bringing together thousands of the world's best athletes to compete in various events. The Olympic Games are held every four years, except in 1916 and 1940 due to World War I and World War II, respectively.

Olympic Games are organized by the organizing committee for the host city or region. This committee is responsible for planning and executing the games, including choosing the venues, managing the logistics, and ensuring the safety and security of the athletes and spectators.

The Olympic Games consist of both summer and winter editions. The first modern Olympic Games, held in Athens, Greece in 1896, included only nine events, but the number of events and nations has since increased significantly.

The Olympic Games are governed by the International Olympic Committee (IOC), which was founded in 1894 by French educator Baron de Coubertin. The IOC is responsible for managing the organization and rules of the Olympic Games, as well as overseeing the Olympic Movement worldwide.

The Olympic Games involve athletes from all over the world, representing their countries and competing for both personal glory and national pride. The Olympic spirit promotes peace and understanding through sport, encouraging athletes to compete with honor and respect.

The Olympic Games are also a significant economic event, providing a boost to the host city's economy, including tourism, hospitality, and other related industries. The Olympic Village, where the athletes live and train during the games, is a hub of activity and excitement.

In conclusion, the Olympic Games are a marvel of international cooperation and athletic achievement, bringing together nations and individuals from around the world to celebrate the spirit of fair play and excellence.
• There isn’t a single model to rule them all
  • Product Lifecycle Management
  • Computational Fluid Dynamics
• Truth Comes in different shapes
  • Descriptive Truth
  • Mathematical Truth
• Let each model act to its strengths
  • Each tool has a specific purpose
  • Optimize the infrastructure
• Integration is the core of MBSE
  • Ensure data used is authoritative
  • Create the collaborative engineering space
Federated Engineering Environment

Models generate from models via model refs

Architecture, pass data values via model refs

Reports, generate from models

Digital Thread
Summary

Global Product Data Interoperability Summit | 2019

Well, that took forever...

Here’s the approved report containing the data requested!

Thanks!

Engineering Silos

<table>
<thead>
<tr>
<th></th>
<th>1990’s</th>
<th>2010’s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office Productivity</td>
<td>Go buy and install MS Office</td>
<td>Google Docs</td>
</tr>
</tbody>
</table>

Model as a Service

Federated Source of Truth