Analysis of Integration and Test (I&T) Costs for Recent NASA Missions

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Introduction

- **Common practices:**
  - Percentage of spacecraft hardware costs
  - Analogies to similar missions adjusted for mission specifics
  - Bottom Up Estimate (BUE)

- **Objective is to develop a parametric CER from APL’s historical data that calculates the total cost of I&T based on parameters**
  - Parameters considered:
    - Number or type of instruments, number of spacecraft, year the mission launched, total mission cost, total hardware cost, etc.
Assumptions

- **Cost Assumptions:**
  - Costs gathered by month from internal records
  - Inflated to FY15$ using NASA New Start Inflation
  - APL missions used as the basis for the CER are:
    - NEAR, Contour, New Horizons, MESSENGER, STEREO, and Van Allen Probes
  - Costs for I&T include:
    - Integration of the spacecraft subsystems and instruments
Assumptions (continued)

Points of Integration Calculation:

- Count up the number of spacecraft subsystems across all spacecraft
  - Excludes software and count PDU separately
- Count up the number of instruments across all spacecraft
  - Treat instrument suites as on point of integration
- If spacecraft I&T costs are not bookkept with observatory I&T you can exclude their points of integration in the total count

Example:

- STEREO (2 spacecraft)
  - 18 Subsystems + 8 instruments = 26 points of integration
The below chart shows the results of the regression analysis of the points of integration vs. cost.
Risk Analysis

- Using the CER to predict the I&T costs for the historical missions shows the prediction error ranges of the CER.

<table>
<thead>
<tr>
<th>Mission</th>
<th>Prediction Error</th>
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<tbody>
<tr>
<td>New Horizons</td>
<td>-6%</td>
</tr>
<tr>
<td>STEREO</td>
<td>5%</td>
</tr>
<tr>
<td>MESSENGER</td>
<td>-16%</td>
</tr>
<tr>
<td>Van Allen Probes</td>
<td>-2%</td>
</tr>
<tr>
<td>Contour</td>
<td>7%</td>
</tr>
<tr>
<td>NEAR</td>
<td>29%</td>
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</tbody>
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- As shown the CER is bounded by 29% and -16% on the extremes.
  - This information can be used to construct uncertainty ranges around cost generated by the CER.
The figure below shows the uncertainty ranges inherent in the CER.
Further Investigations

- Explore points of integration down to a lower level
- Incorporate external missions