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The Economic Importance of Adequate Aeronautical Telemetry Spectrum

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Outline

- Introduction
- Context & scope
- Overview of economic model
- Methodology
- Preliminary results
Introduction

- The flight test community faces a telemetry spectrum crunch
- Amount of spectrum now allocated for ATM is not sufficient to meet needs and requirements have been steadily growing

ATM spectrum is vital to both commercial and military flight testing
- There are economic implications associated with the allocation of spectrum for ATM
- Economic considerations are important to the proposal currently before the ITU
  - Agenda Item 1.5 of WRC 2007 calls for the allocation of additional spectrum for wideband ATM in the 3-30 GHz band
Context & Scope

- MITRE tasked to build a model to evaluate the economic importance of having adequate accessibility to ATM spectrum
- MITRE team developed robust economic analysis methodology to forecast future scenarios
  - Exercised conservatism in modeling costs
Overview of Economic Model (1 of 2)

- MITRE team established probable future scenarios on a test range over a twenty year period (2004-2024)
- Current supply and estimated demand of ATM spectrum on a range on an annual basis over 20 years
  - Calculated the resulting “gap”

ATM: Aeronautical Telemetry; MHz: Megahertz
Overview of Economic Model (2 of 2)

- Identified and estimated cost impacts of the Gap

- This insight substantiates the criticality of spectrum augmentation

Identified and estimated cost impacts of the Gap

- Technology Investments
- Test Delays
- Test Infrastructure Enhancements
- Inadequate Testing

This insight substantiates the criticality of spectrum augmentation
Methodology – Demand & Supply

1. **Demand**
   - Current spectrum shortfall
   - Geographic reuse loss
   - Growth rate
   - Major test program requirements
   - Schedule overhead

2. **Supply**
   - Current/future allocation
   - Potential WRC augmentation
   - Adoption rate for new spectrum

- Greater system complexity
- High definition video
- Shorter acquisition cycles
Methodology – Demand (1 of 2)

- Demand is defined as requirements for ATM spectrum
- Model applies well-accepted projections
  - Current ATM shortfall in spectrum-congested area is 17%*
  - Geographic reuse loss in spectrum-congested area is 8%*
  - ATM spectrum growth has and will continue to follow Moore’s Law

- Step-wise growth estimates incorporate benefit of technology investments

ATM: Aeronautical Telemetry; Kbps: Kilobits per second;
*Sarnoff Requirements Study
Model incorporates new (conservative) demand findings

- Schedule overhead of 10%
- Major test program requirements:
Supply is defined as spectrum that may be used for ATM

- Current allocation of 215 MHz
- Developed scenarios to evaluate potential spectrum augmentation from WRC (0 to 650 MHz)
  - New technologies needed to access additional spectrum
  - Adopted over time by range and program managers
Methodology – Technology Investment

- There are costs and potential benefits of investments in technology research initiatives.
- Estimated annual investment costs for ARTM, Tier 1 & 2 technologies, iNet, use of very high frequency bands (e.g., 8 GHz), and other unforeseen, promising technologies.

Potential benefits (e.g., improved efficiencies) of these investments are incorporated within growth rates of demand data.
There are costs associated with unplanned test delays due to insufficient ATM spectrum access.

There are unplanned delays on a test range today:
- One large test delay per week costs $1M
- Three small test delays per week cost $50K x 3 = $150K

Today, test delays due to insufficient ATM spectrum access cost $60M per year!
Examined cost to provide new or additional range resources for flight testing in different geographic areas
   - Huge cost to programs and national economy

Issues remain:
   - Are there alternative ranges available far enough away from existing ranges to allow for spectrum reuse?
   - Will legal, environmental, and political consent be given to provide new range resources far enough away from existing ranges accessing ATM spectrum to allow for spectrum reuse?

In the present environment, these are not realistic options!
Methodology – Inadequate Testing

- Model incorporates cost of inadequate testing
- Lack of access to ATM spectrum leads to test point shedding which leads to reduction in test quality
- At some point, not testing results in catastrophes and fatalities
- Based on specific cost of inadequate testing case

- **30 lives lost!***
  - GAO: in part due to inadequate test & evaluation**
    - To meet cost and schedule targets, actual testing conducted was less than a third of that originally planned
- **$1.6B per incident!***
Preliminary Results

- Costs are significantly mitigated by:
  - Reducing testing delays (via spectrum augmentation and/or test infrastructure enhancements)
  - Decreasing inadequate testing
- Model does not incorporate the risk of depending on test infrastructure enhancements
  - Legal, environmental, political, and large upfront investment hurdles may not be overcome
  - In present environment, not a realistic option

- WRC spectrum augmentation of 650 MHz is only scenario in which requirements are met

- Our choices today will determine how we will flight test in the future
- Will we be able to efficiently develop innovative aerospace products?
Back-Up
## Scenario Definitions

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>Year Requirements Are Met</th>
<th>Mitigated Year 2024 Gap</th>
<th>New Range Resources</th>
<th>Yearly Accident Rate</th>
<th>Schedule Overhead</th>
<th>Adoption Rate</th>
<th>Spectrum Augmentation</th>
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<tr>
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<td>0.00</td>
<td>Yes</td>
<td>Med</td>
<td>650</td>
</tr>
</tbody>
</table>
**Cost Components**

### Baseline

- **Technology Investment Costs**: 0.4%
- **Cost of Testing Delays**: 50.5%
- **Inadequate Testing**: 49.1%

### WRC 0

- **Cost to Provide New Range Resources**: 11.9%
- **Technology Investment Costs**: 1.1%
- **Inadequate Testing**: 71.8%
- **Cost of Testing Delays**: 15.1%

### WRC 60

- **Cost to Provide Additional Range Resources**: 6.3%
- **Technology Investment Costs**: 1.1%
- **Cost of Testing Delays**: 23.6%
- **Inadequate Testing**: 68.8%

### WRC 200

- **Cost to Provide Additional Range Resources**: 0.3%
- **Technology Investment Costs**: 1.4%
- **Inadequate Testing**: 64.1%
- **Cost of Testing Delays**: 34.2%

### WRC 650

- **Cost to Provide Additional Range Resources**: 1.5%
- **Technology Investment Costs**: 8.5%
- **Inadequate Testing**: 1.5%
- **Cost of Testing Delays**: 90.0%

- **Dollar value of tech investment costs remain constant**
- **Baseline**: roughly equal split of remaining costs
- **In WRC cases**:
  - **Cost of testing delays**: 15.1% to 50.5%
  - **Cost of additional range resources**: 0.1% to 0.3%
  - **Cost of new range resources**: 6.3% to 11.9%
  - **Inadequate testing**: 0% to 49.1%