Black Box Design

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Overview

Functions:
- Video/Audio Recording
- Vehicle Event Recording
- On-Board Diagnostics
- Internal Components Should Withstand 3400g and 1000°C
- Mirroring for Fault Tolerance
- Solid-State Disk for Reliability
- Environmental Status
- Tamper-Resistance: Encrypted Data, TPM

Sensors:
- Pressure Sensor
- Cameras

Communication:
- Wireless monitoring through Satellite
Problem Statement

- Provide feedback about the status and health of the vehicle
- Record accident data
- Provide security of data
- Can be used by:
  - Field Technician Soldiers
  - Command Center Mechanic
  - Data Analyst
- Can Be Used At:
  - Field
  - Command Center
Vehicle Tracking through GPS
- Remotely monitoring vehicle status
- Accident Prediction, avoiding catastrophic failure
- Detect and report the reliability of the vehicle
- Efficiency data to improve vehicle and overall system performance
- Modular versatility that allows integration into several types of vehicles
Project Stakeholders

- ENES489P Black-Box Team and Advisors
- Military Logistics Agency
- Soldier
- Budget
- Military Doctrine
- Manufacturers
Use Cases

- Use Case 1: Installation and Testing
- Use Case 2: Operation
- Use Case 3: Retrieving Data
- Use Case 4: Threats to System/Reliability
- Use Case 5: Maintenance
Use Case 1: Installation and Testing

Mechanic receives black box from systems analyst

Input Number of Sensors
Input Types of Sensors
Input compartment dimensions

Test Software verifies compatibility

Is the black Box compatible?
Yes
No

Mechanic installs black box

Installed Correctly?
Yes
No

Notify manufacture

Minor calibration needed
Major reconfiguration required
Use Case 2: Normal Operation

Data is also stored (same manner as the computer hard-drive) in the external hard-drive.

Retrieve GPS/OBD2/camera retriever data via computer’s USB interface, and process it.

Data is processed and displayed on the monitor.

GPS/OBD2/camera software uses/manipulates data.

Data is also stored in the computer hard-drive in 1-minute data packets designated as ‘good’ data or ‘bad’ data.

Data reaches 76% capacity in computer hard-drive or external hard-drive.

Data Recorder acts in accordance with the ‘Accidents’ Operation Mechanisms (has its own used case activity diagram).

Data Rotator program deletes the oldest ‘good’ excessive data.

Data retrieval (has its own used case activity diagram).

Black Box Design
Use Case 3: Retrieving Data

1. Local Access?
2. Check Power
3. Power On Black Box
4. Black Box Active?
5. Connect Reader
6. Log In
7. Download Data
8. Release Reader
9. Locate Vehicle On Map
10. Initiate Connection
Use Case 4: Accident Operations/Reliability

- Combat Effects
- Combat Effects

Car Accident?
- YES
  - Is Main Power Supply Available?
    - YES
      - Black Box operating under normal conditions
    - NO
      - Data Rotator software does not delete oldest ‘Good’ data. Records until it fills up

- NO
  - Data rotator software enables system to act under normal conditions for 30 minutes and then switches to a locator beacon.
Use Case 5: Maintenance

- Black Box
- All Sensors Functional?
- Receive Data
- Compare Data to Historic Data
- Abnormal Data?
- Alert Operator Error Code and Sensor
- Send Signal to Command Center
- Vehicle Operational?
- Return Home
- Command Center Dispatches Assistance
System Design

On-Board Diagnostics
Built-in vehicle sensor network for various vehicle sub-systems

Black Box (Obsecured)
Located below seating area for obsecurity

Pressure Sensors
Used for passenger detection

Camera/GPS/Monitor
Records vehicle interior events, provide user feedback of black box, and provides location data

Front Boundary Camera

Right Boundary Camera

Left Boundary Camera

Rear Boundary Camera

On-Board Diagnostics
Built-in vehicle sensor network for various vehicle sub-systems
## High Level Requirements

<table>
<thead>
<tr>
<th>Requirement 1</th>
<th>Be as indestructible as possible</th>
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<tbody>
<tr>
<td>Requirement 2</td>
<td>Be mountable to army vehicles</td>
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<tr>
<td>Requirement 3</td>
<td>Store data from camera, vehicle sensors, and location (GPS)</td>
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<tr>
<td>Requirement 4</td>
<td>Have accessible data for army command and base centers</td>
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<tr>
<td>Requirement 5</td>
<td>Be tamper-resistant</td>
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<td>Requirement 6</td>
<td>Accommodate accident-scenarios</td>
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<td>Requirement 7</td>
<td>Have accessible data displayed for Field-Technician Soldiers</td>
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<td>Used Case</td>
<td>High-Level Requirement</td>
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<td>-------------------</td>
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<tr>
<td>Normal Operations</td>
<td>Requirement 3</td>
</tr>
</tbody>
</table>
Trade-Off Analysis: Performance vs. Cost

The graph shows a scatter plot comparing performance versus cost for different models. Each point on the graph represents a specific model, with the x-axis indicating cost and the y-axis indicating performance. The models are distinguished by different markers and colors, with specific performance and cost values indicated for each point. The legend on the right side of the graph lists the markers and their corresponding model codes.
Trade-Off Analysis: Power Efficiency vs. Cost

Power Efficiency vs Cost
(Higher power = more efficient)

Cost

Power Efficiency

3.5
3
2.5
2
1.5
1
0.5
0

0
500
1000
1500
2000
2500
3000
3500
4000

3650
3370
3310
2050
1770
1710
1640
1280
1070
940
935
875
Trade-Off Analysis: Performance vs. Power Efficiency

![Performance Efficiency vs Power Graph](image-url)

- **Performance Efficiency vs Power**

  - Axes:
    - Performance
    - Power

  - Data points for various models:
    - 3650
    - 3370
    - 3310
    - 2050
    - 1770
    - 1710
    - 1640
    - 1280
    - 1070
    - 940
    - 935
    - 875
## Summary

<table>
<thead>
<tr>
<th>Trade-Off Curve</th>
<th>Points of Interest</th>
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<tbody>
<tr>
<td>Performance vs Cost</td>
<td>22, 1, 10, 27, 17</td>
</tr>
<tr>
<td>Power Efficiency vs Cost</td>
<td>27, 22, 24, 17, 13, 1</td>
</tr>
<tr>
<td>Performance vs Power</td>
<td>1, 7, 27, 17, 22</td>
</tr>
<tr>
<td>All</td>
<td>22, 1, 27, 17</td>
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