# Electronically Controlled Braking Systems Field Operational Test (ECBS FOT)

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***Office of Applied Vehicle Safety Research***
***Driver-Vehicle Interaction & Heavy Truck Research Division***

# Agenda

- FOT Introduction
- Test Approach & Templates
- The Technologies
- Vehicle Fleet
- Data Collection & Project Schedule

# Introduction
## DOT Initiatives

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- Accelerate deployment of new safety technologies to reduce accidents & fatalities
- Demonstrate benefits, measure reliability and advance state of the art of heavy truck ECBS & ABS technology
  - Laboratory and track testing (SAE/RAI)
  - Field testing in real-life commercial operations
- August 2002: RFA for ECBS Field Operational Tests
  - Template 1: Severe Duty Truck
  - Template 2: "Mixed" Tractor-Trailer
  - Template 3: "Optimized" Tractor-Trailer

→ **Combined FOT**

- May 1, 2003: Award made to the Freightliner Team for a combination of Templates 2 and 3

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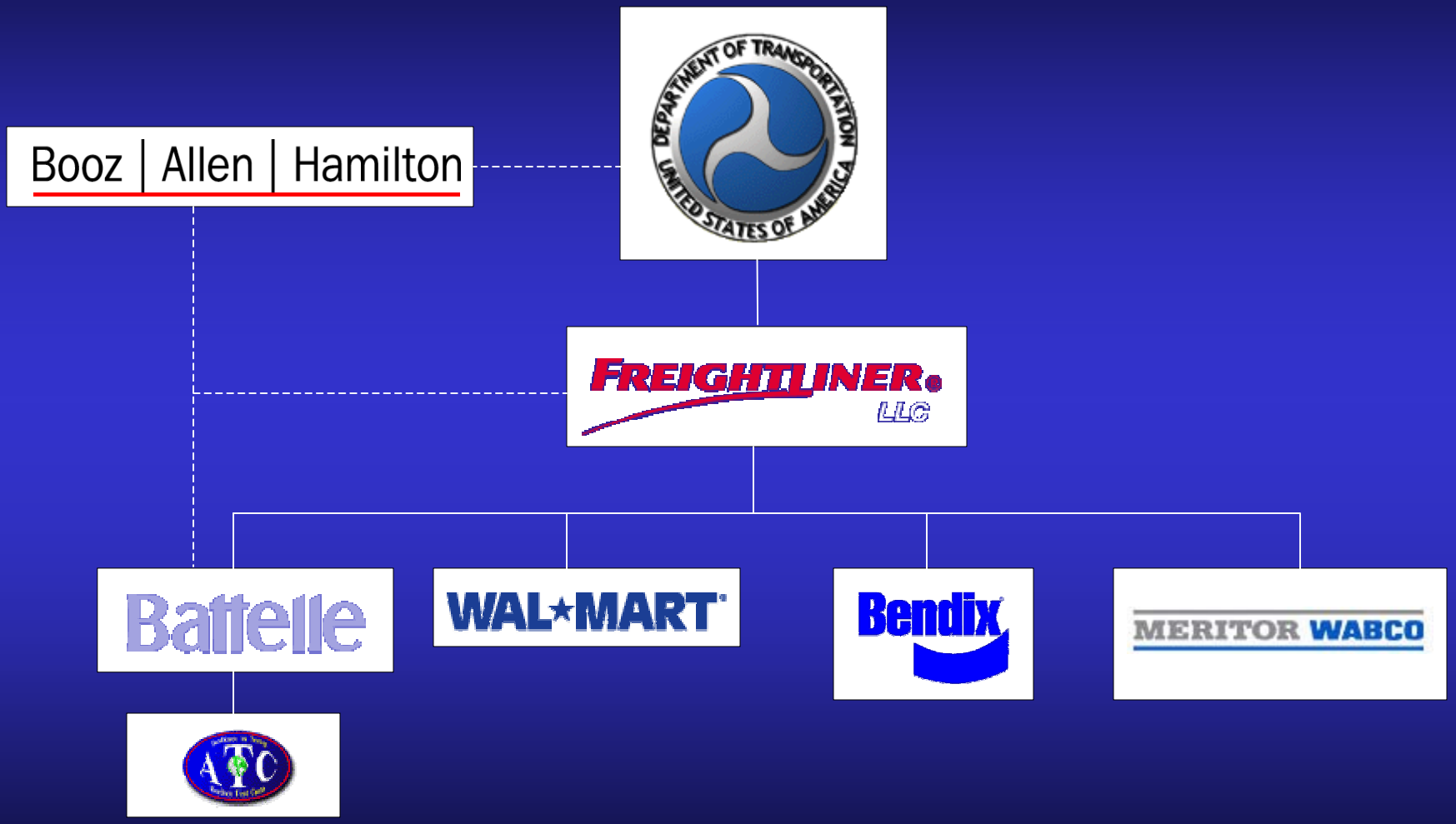
# FOT Team Structure



# Goals and Objectives

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**Overall Goal**

***Evaluate the safety, performance, reliability, maintainability and durability of ECBS, ABS and enabled safety technologies***

**Template 2 Objective: "Mixed" Tractor-Trailers**

***Evaluate the compatibility and performance of unmatched combinations of tractors and trailers equipped with ABS or ECBS from multiple suppliers***

**Template 3 Objective: "Matched" Tractor-Trailers**

***Evaluate ECBS and ECBS-enabled safety technologies on matched tractor-trailers with brake control systems from the same suppliers***

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# Test Approach

- Install ECBS and ABS with enabled safety technologies on Freightliner tractors and Great Dane trailers purchased by WAL*MART
- Operate vehicles in WAL*MART real-life commercial operations for 12 months
  - Collect vehicle onboard system data, maintenance data, fleet operator and driver experience, and safety-related data
- Provide information to DOT and the Independent Evaluator for analysis and evaluation throughout the FOT

# Template 2:
## Quantity of Tractor & Trailers

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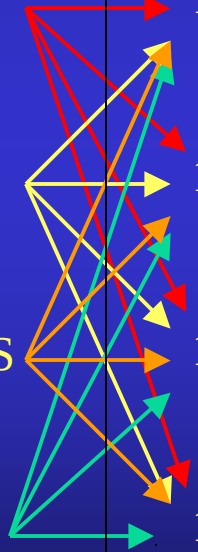
### *"Mixed" Tractor-Trailer*

| Group | Tractors | | Trailers | |
|---|---|---|---|---|
| *T2-Config.1* | 10 | Meritor Wabco ABS *w/ Arvin Meritor drum* | 15 | Meritor Wabco ABS *w/ Arvin Meritor drum* |
| *T2-Config.2* | 10 | Meritor Wabco ABS *w/ Bendix Knorr disc* | 15 | Meritor Wabco ABS *w/ Bendix Knorr disc* |
| *T2-Config.3* | 10 | Meritor Wabco ECBS *w/ Bendix Knorr disc* | 15 | Meritor Wabco ECBS *w/ Bendix Knorr disc* |
| *T2-Config.4* | 10 | Bendix ABS6 *w/ Bendix Knorr disc* | 15 | Bendix EBS *w/ Bendix Knorr disc* |
| | **Total 40** | | **Total 60** | |



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# Template 2
## Experimental Plan

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- **Phase 1:**
  - 6 Months Duration
  - Enabled Technologies “OFF”
    - Data recorded, but does not affect operations
- **Phase 2:**
  - 6 Months Duration
  - Enabled Technologies “ON”
    - Data recorded and fully functional interactive systems

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# Template 3
## Number of Tractor & Trailers

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### *"Optimized" Tractor-Trailer*

| Group | Tractors | | Trailers | |
|---|---|---|---|---|
| *T3* | 8 | Meritor Wabco ECBS *w/ Bendix Knorr disc* | 40 | Meritor Wabco ECBS *w/ Bendix Knorr disc* |
| | **Total 8** | | **Total 40** | |

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# Template 3
## Experimental Plan

- **Phase 0:**
  - Profile drivers in ABS tractors prior to operation of ECBS tractors
- **Phase 1:**
  - 6 Months Duration
  - ECBS with Enabled Technologies “OFF”
    - Data recorded, but does not affect operations
- **Phase 2:**
  - 6 Months Duration
  - ECBS with Enabled Technologies “ON”
    - Data recorded and fully functional interactive systems

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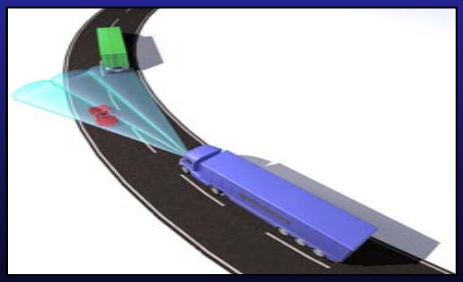
# Meritor WABCO Technologies

## Tractor:

- Electronically Controlled Braking System (ECBS)
  - Pneumatic control lines and logic replaced with electronics
  - Platform for future advanced technologies
  - Full pneumatic redundancy in the event of a major electrical malfunction
- Electronic Stability Control (ESC)
  - Attempts to correct instabilities caused by roll and yaw inducing maneuvers
  - Assists driver to follow intended course
- Adaptive Cruise Control (ACC)
  - Extension of Cruise Control
  - Automatic control of engine, engine brake & foundation brakes to maintain a safe following distance
  - Collision warning capability



# Meritor WABCO Technologies

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## Tractor:

- Baseline ABS Systems
- ABS with Brake Performance Monitoring
  - Detects degraded brake performance
- ABS with Roll Stability Control
  - Attempts to correct instabilities caused by roll inducing maneuvers

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# Meritor WABCO Technologies

## Trailer:

- Standard ABS
- Electronically Controlled Braking System (ECBS)
  - Pneumatic control lines and logic replaced with electronics
  - Electronically controlled by ECBS tractor or pneumatically controlled by ABS tractor
  - Platform for future advanced technologies
  - Full pneumatic redundancy in the event of a major electrical failure
- Roll Stability Support (RSS)
  - Attempts to correct instabilities caused by roll inducing maneuvers

# Bendix Technologies

## Tractor:

- Premium ABS6 Features
  - Anti-lock braking
  - Automatic traction control
  - Brake system monitoring and diagnostics
- Air Disc Brakes
  - Increased braking torque
  - Resistance to brake fade
  - Reduced hysteresis & improved side-to-side brake balance
  - Improved brake diagnostics
  - Lining wear sensing
  - Reduced maintenance downtime & parts count

# Bendix Technologies

## Trailer:

- ECBS (TEBS4) Features
  - Closed-loop service brake pressure control
  - Lining wear monitoring  for air disc brakes
  - Brake system monitoring and diagnostics
- ECBS Enabled Technologies
  - Trailer roll stability program (TRSP)
- Air Disc Brakes
  - Increased braking torque
  - Resistance to brake fade
  - Reduced hysteresis & improved side-to-side brake balance
  - Improved brake diagnostics
  - Lining wear sensing
  - Reduced maintenance downtime & parts count

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# WAL*MART
## Freightliner Columbia Tractors

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# WAL*MART
## Fleet Operations

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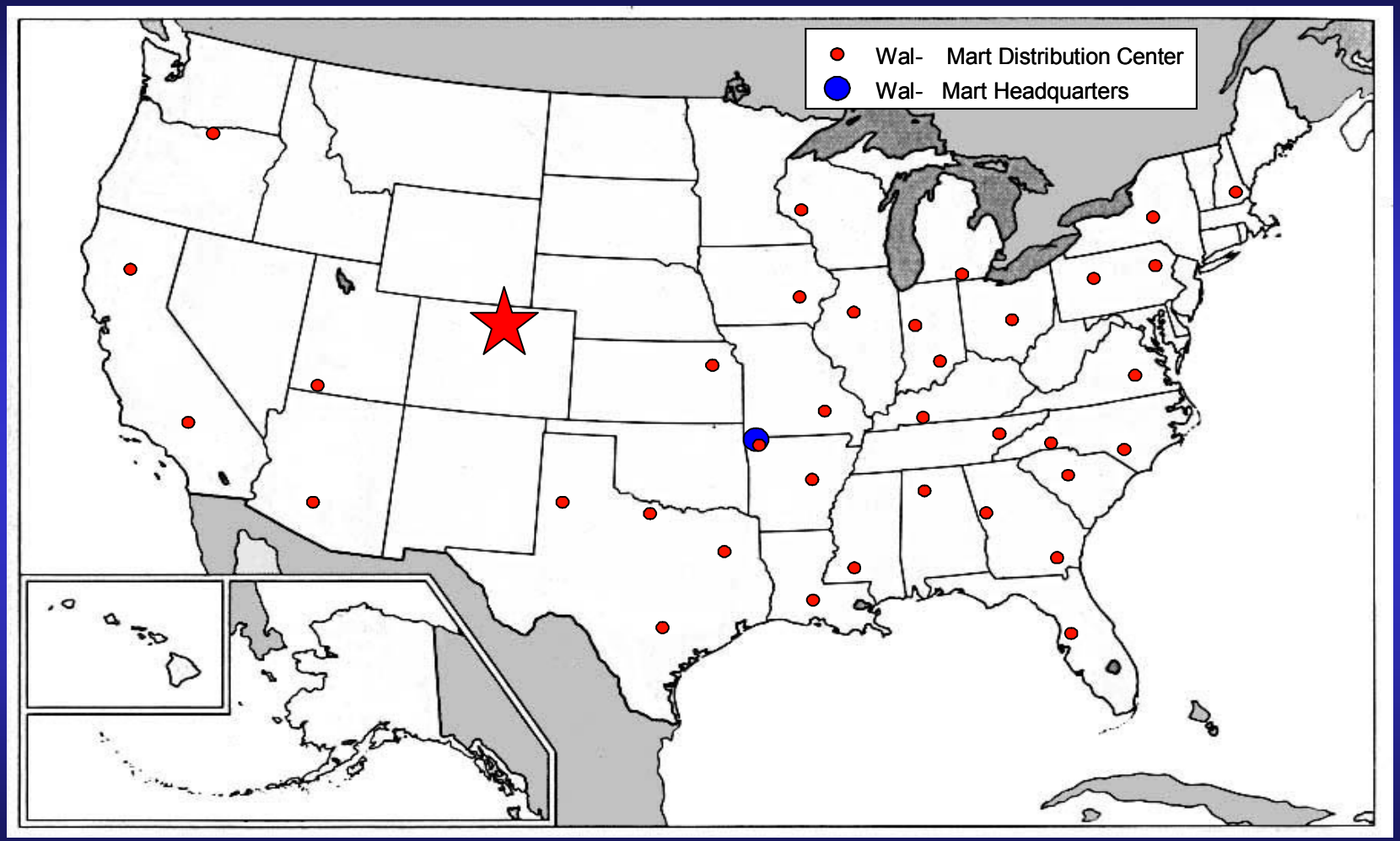
- Distribution of perishables and dry goods
- 24 / 7 Operations
- Hub-and-Spoke operations
  - Deliveries from hubs to distribution centers (DC), and from DC to WAL*MART stores, SuperCenters or Sam's club stores
- National operations
  - 38 Distribution Centers (Terminals)
  - > 4,700 stores, SuperCenters and Sam's club stores

# Distribution Center - Loveland, CO



# WAL*MART
## Loveland Fleet Statistics

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- **Operations**
  - Approx. 217 Tractors & 1000 Trailers
  - Freightliner 58” Columbia RR Sleeper Cab
  - Single Trailers
  - Average of 125,000 miles / year / tractor
  - Average trip: ~ 250 miles (one way), one or more deliveries
  - Variety of routes and weather (highways, urban and/or country roads, mountains, plains)
- **Drivers**
  - Assigned to their own tractor
  - ~ 14 years experience with WAL*MART
  - < 1% driver turn-over rate

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# Data Sources

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- Onboard Driving & Equipment Data
- Fleet Operations and Maintenance Data
- Surveys and Interviews
- Safety Benefits Data
- Relevant Fleet Historical Information

# Data Transfer
## On-Board Vehicle Data

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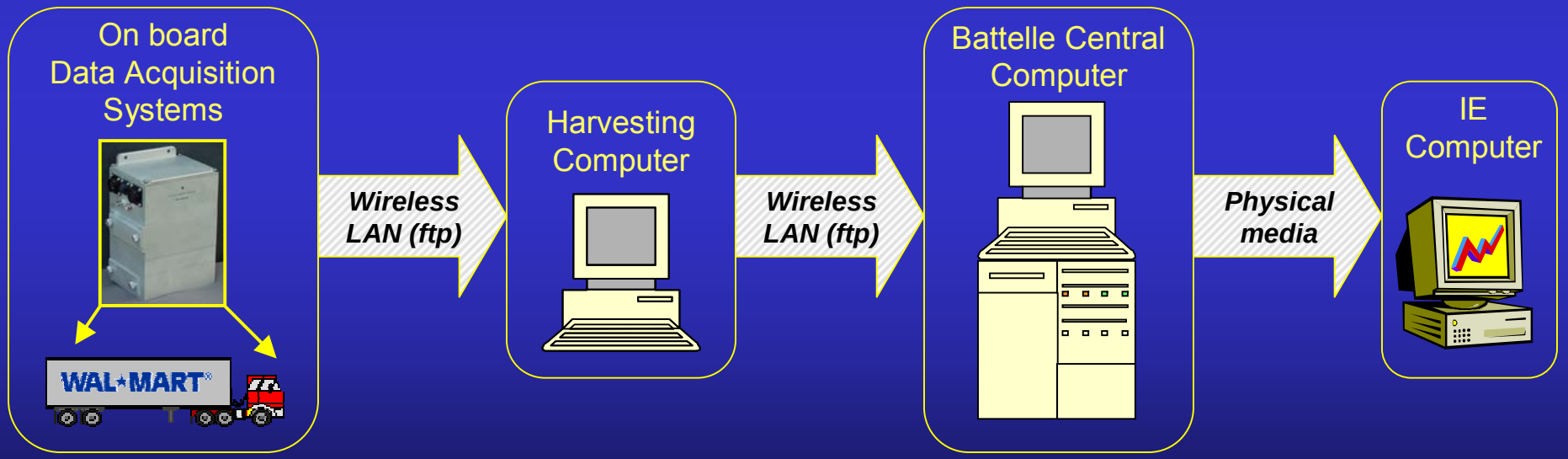
| Step 1 | Step 2 | Step 3 | Step 4 | Step 5 | Step 6 |
|---|---|---|---|---|---|
| Onboard data collection & storage | Data download to local PC | Local data validity checks | Data upload to Battelle | Data validation and storage | Data delivery to IE |

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# Program Schedule & Work Plan Highlights

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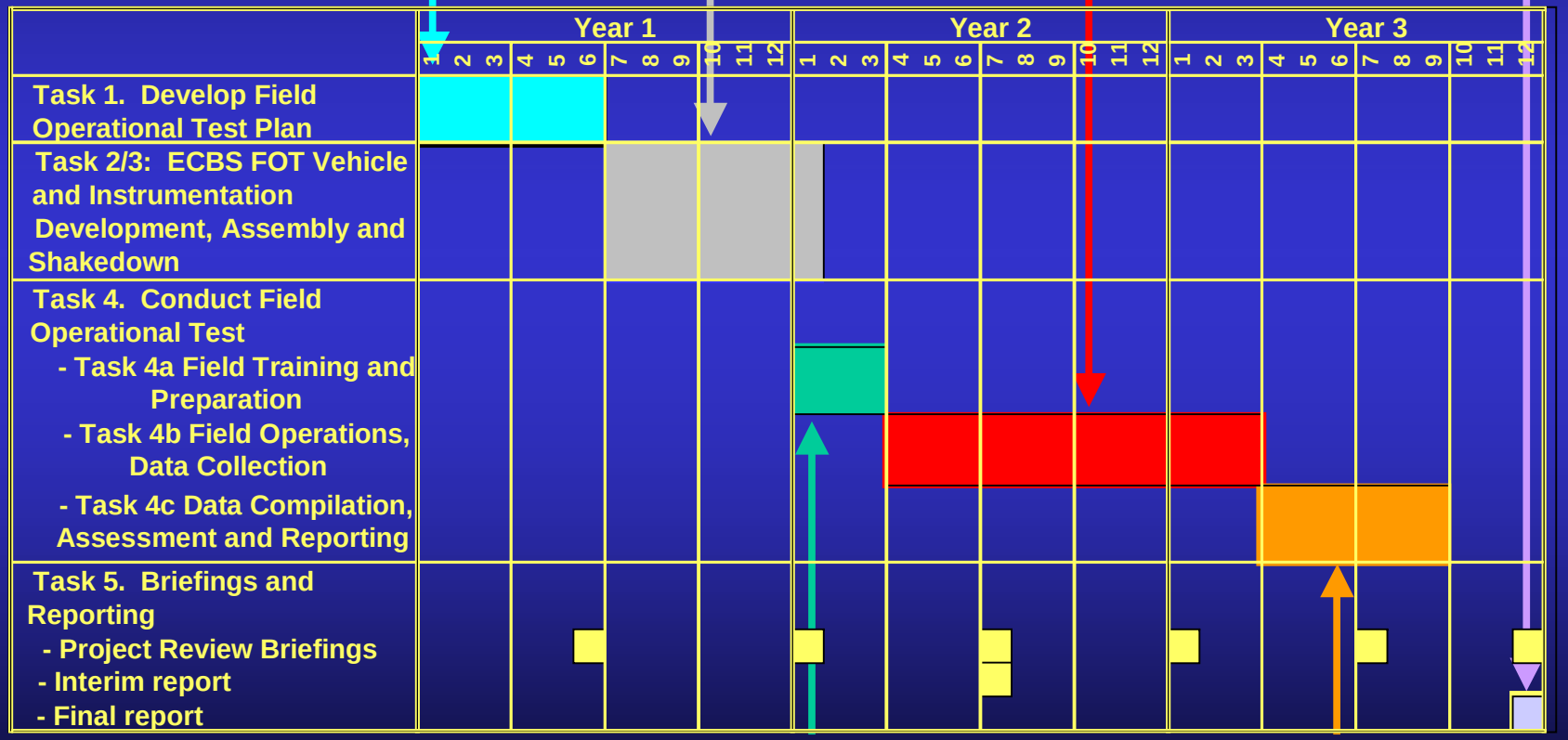
MAY '03 – Dec. '03
Develop & Finalize
FOT Test Plan

NOV. '03 – MAY '04
Vehicle build and
checkout

AUG. '04 – JULY '05
Data Collection

APR. '06
Final Report




MAY '04
Field Training

AUG. '05 – JAN '06
Data Analysis w/IE

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# Thank you!

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