EPA's Plan for MOVES: A Comprehensive Mobile Source Emissions Model

Emissions Inventories--Partnering for the Future
Atlanta, April 17, 2002

John Koupal, Harvey Michaels, Mitch Cumberworth, Chad Bailey, and Dave Brzezinski

U.S. EPA, Office of Transportation and Air Quality, Ann Arbor MI

MOVES

- **M**ultiscale
- m**O**tor
- **V**ehicle and equipment
- **E**missions
- **S**ystem

Outline

- Why a new mobile source model?
- Use Cases
- Conceptual Design
- Analysis of Emission Data
- Software Design and Development
- Implementation Plan and Timeline

Why a New Mobile Source Model?

- Comprehensive
- Multiscale
- Able to calculate uncertainty
- Able to take advantage of on-board data
- Interface with other models
- Easy to use
- Easy to update

Objectives of MOVES

- Increase scope and flexibility
- Improve the science
- Improve the software

Use Cases: Focus on broad purpose

- Inventory development for EPA Reports and Regulations
- Inventory development for regulatory requirements
- Policy evaluation
- Hot spot and project level analysis
- Model validation and uncertainty
- Model updates and expansion

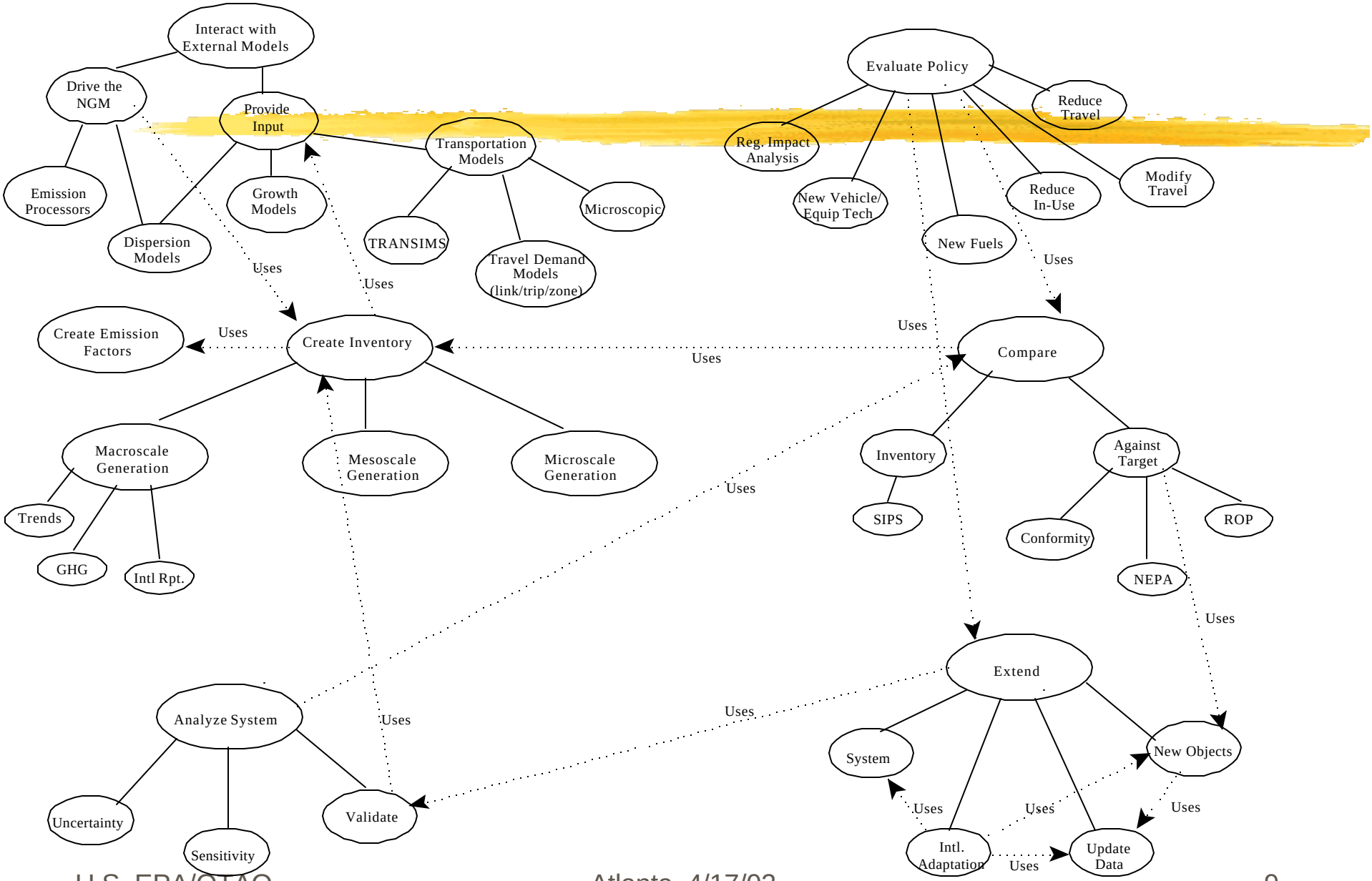
Use Cases: Focus on I/O

- Macroscale, mesoscale, microscale, each of which requires different inputs
- Inputs and output exchanged with other models

Use Cases: Focus on user interaction

- A powerful, versatile GUI
- Batch interface
- Flexible I/O formats
- Output processing
- Accept MOBILE-like inputs, produce MOBILE-like outputs

Use Cases Hierarchy



Conceptual Design

- Emission processes
- Generic approach
- Total activity as vehicle-time
- Core model/Enhanced model
- Importers for various data sources

Emission Processes

Combustion Products	Hydrocarbon Evaporation	Other
Tailpipe Running Exhaust Tailpipe Start Exhaust Crankcase	Diurnal Hot Soak Resting Loss Running Loss Vehicle Refueling Fuel Leakage Offgassing	A/C Refrigerant Leakage Brake Wear Tire Wear

Emission processes handled separately--each may represent a submodel

Conceptual Model: Definitions

- Fleet bins = vehicle population subcategories that differentiate emissions
- Operating modes = activity categories that differentiate emissions
- Emission rates = most disaggregated
- Emission factors = aggregated

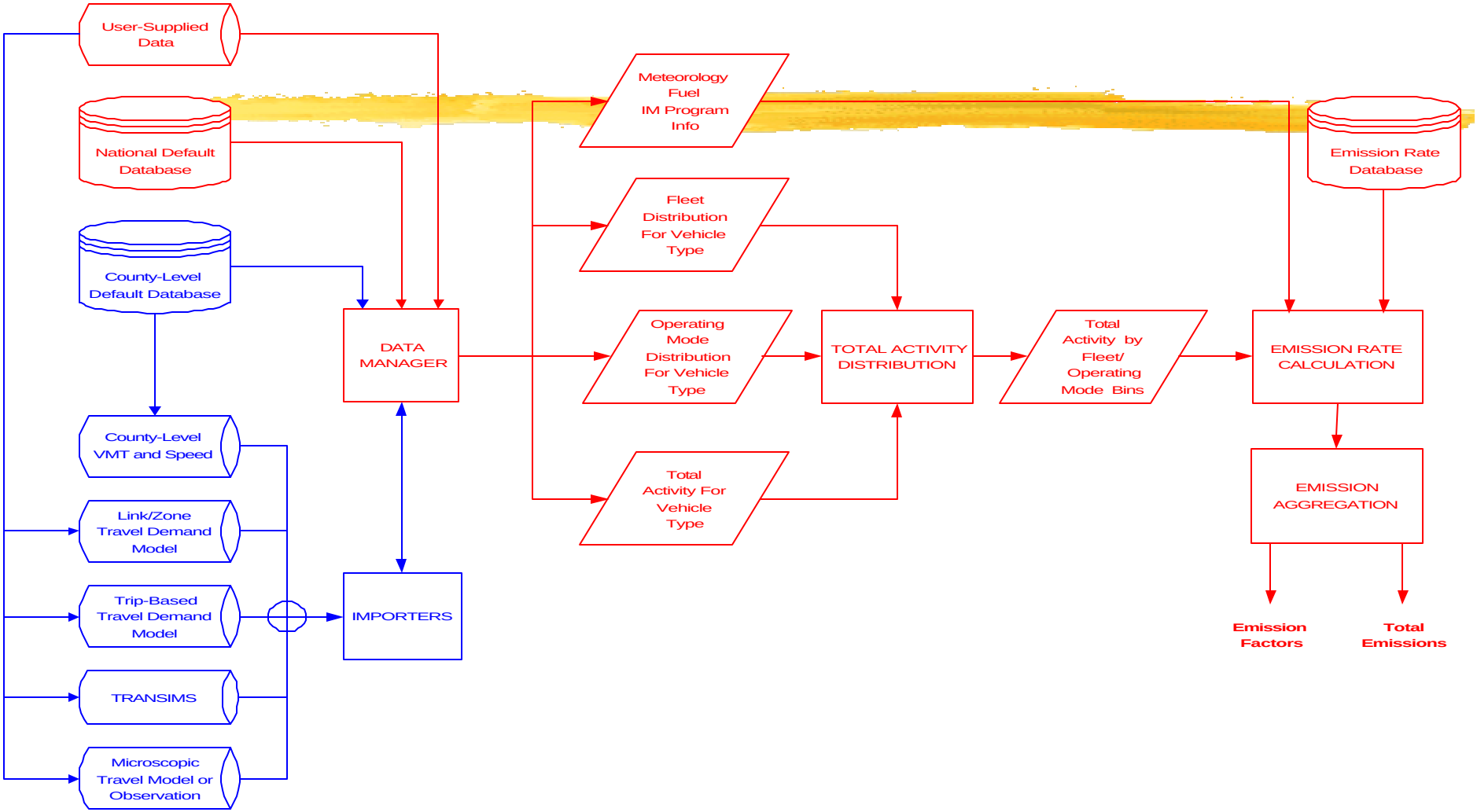
Conceptual Model: Emissions Calculation

- 1. Total activity (vehicle-time)
- 2. Distribute across fleet bins and operating modes
- 3. Calculate/look up Emission Rate for each fleet-operating mode bin
- 4. Aggregate using distributions from Step 2

Generic Emissions Calculation

- Front end
  - Run spec/GUI
  - Importers/data Manager/external model interfaces
- Core Model
  - Fleet activity distributor--differ by emission process
  - Generic emission rate estimator--differ by emission process
- Back end--Aggregate, summarize, external model interfaces

Generic Data Flow



Enhanced System

Core Model

Iterate by Process, Pollutant, Place, Time, Vehicle Type

Layered View of MOVES Design

LAYERS	*COMPONENTS*		
Control 1	Run Spec/GUI		
Control 2	Monte Carlo Controller		
Control 3	Time and Space Looper		
Application 1	Input Data Manager Importers Growth Model	Core Fleet/Activity Distributor Emissions Rate Estimator	Output Aggregate Summarize Analyze Compare Export Visualize Archive Runs
Database 1	Input Databases	ER Databases	Output databases
Utility	Visualization Tools, DBMS Tools, Data Browser, API, MIMS utilities		
Application 2	Data Crank, Extend Model		

Database 2	Archived runs: runs specs and output databases for later comparisons
Database 3	Supporting Data for Data Crank: MSOD, Other data

Analysis of Emission Data

- Objectives:
  - consistency across scales
  - use maximum amount of available data
  - easily updated
  - practical software

Analysis of Emission Data (cont.)

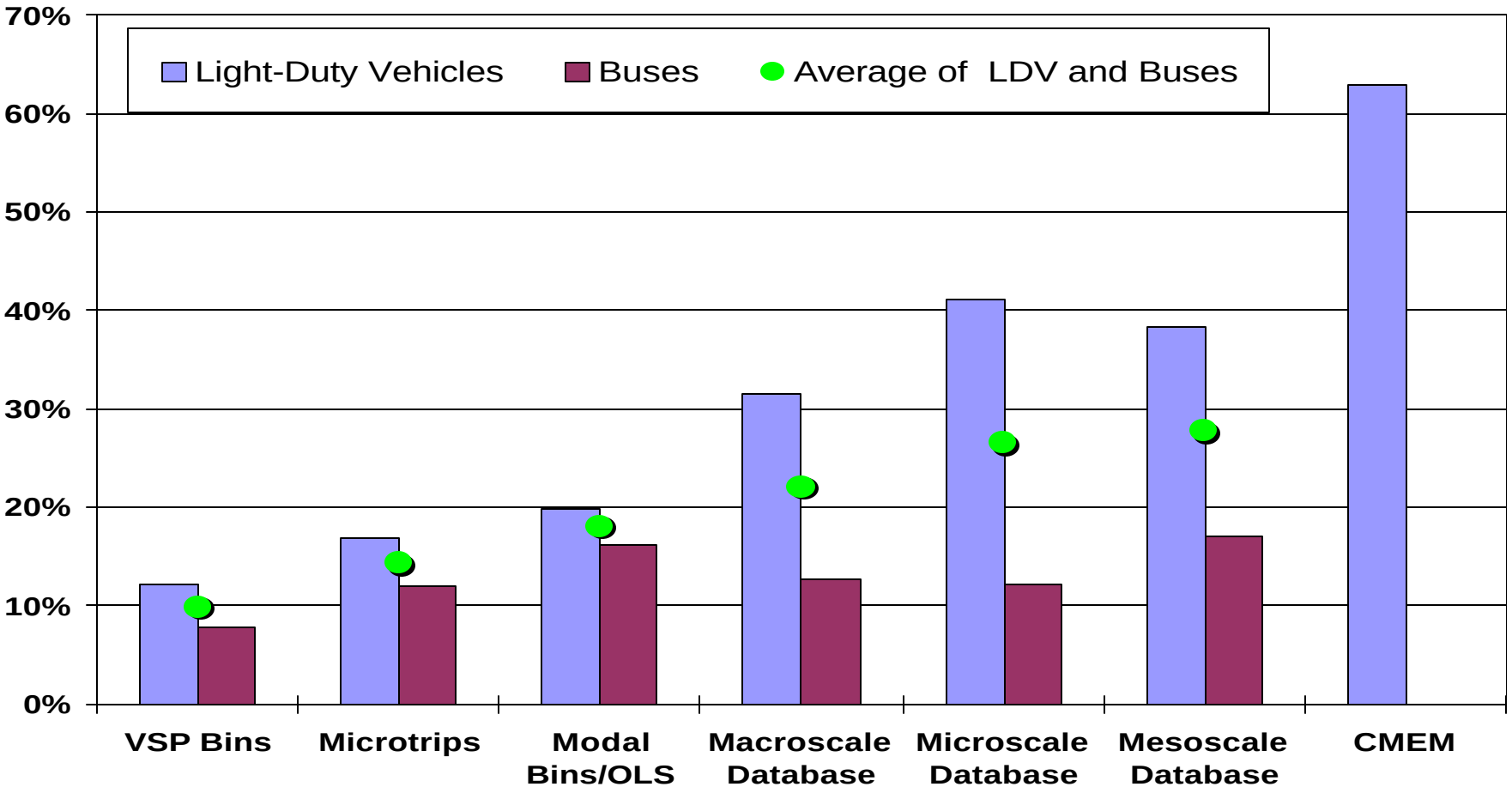
- On Board Emission Analysis Shootout
  - Task
    - 12 LDV, 12 Buses, 3 NR
    - 3 contractors
    - Analysis task
    - Validation

Analysis of Emission Data (cont.)

- On Board Emission Analysis Shootout
  - Approaches
    - Physical model
    - Modal binning
    - Database lookup
    - Microtrip

Analysis of Emission Data:

On-road shootout results summary



Analysis of Emission Data: Feasibility Criteria

Feasibility Criteria	Physical Model	Modal Binning	Database	Microtrip
Consistent Across Scales?	X	X		
Easily Updated?		X	X	X
Can Incorporate Many Data Sources?		X	X	
Software Efficiency?	X	X		X

Software Design

- Goals
  - maintainable
  - extendable
  - well-documented
  - easy to use
- MIMS
- Iterative development

Software Design (cont.)

- Efforts to date
  - Core system (Cimulus, Inc.)
  - Use cases, GUI, and overall design (MCNC)
  - Preliminary decisions
    - Java
    - Unit and system testing
    - Iterative development
- Working on version control, DBMS

Model Quality

- Drafting QAPP
  - Model quality, objectives, and assessments
  - Standards
  - Stakeholder and scientific peer review
- Validation
- Uncertainty
- Peer review

Implementation Plan

- Iterative approach
- GHG Implementation Fall 2003
- HC, CO NOx SOx, PM, NH3, and air toxics on road multiple scales Fall 2005

Summary

- Objectives
- Use cases
- Generic core model and importers
- Emission analysis by modal binning
- Macroscale, mesoscale, microscale
- OO-design in Java, testing, iteration
- QAPP--objectives, testing, peer review
- Produce GHG, then on-road implementation