Benefits and Costs Associated with Maintenance Decision Support Systems (MDSS)

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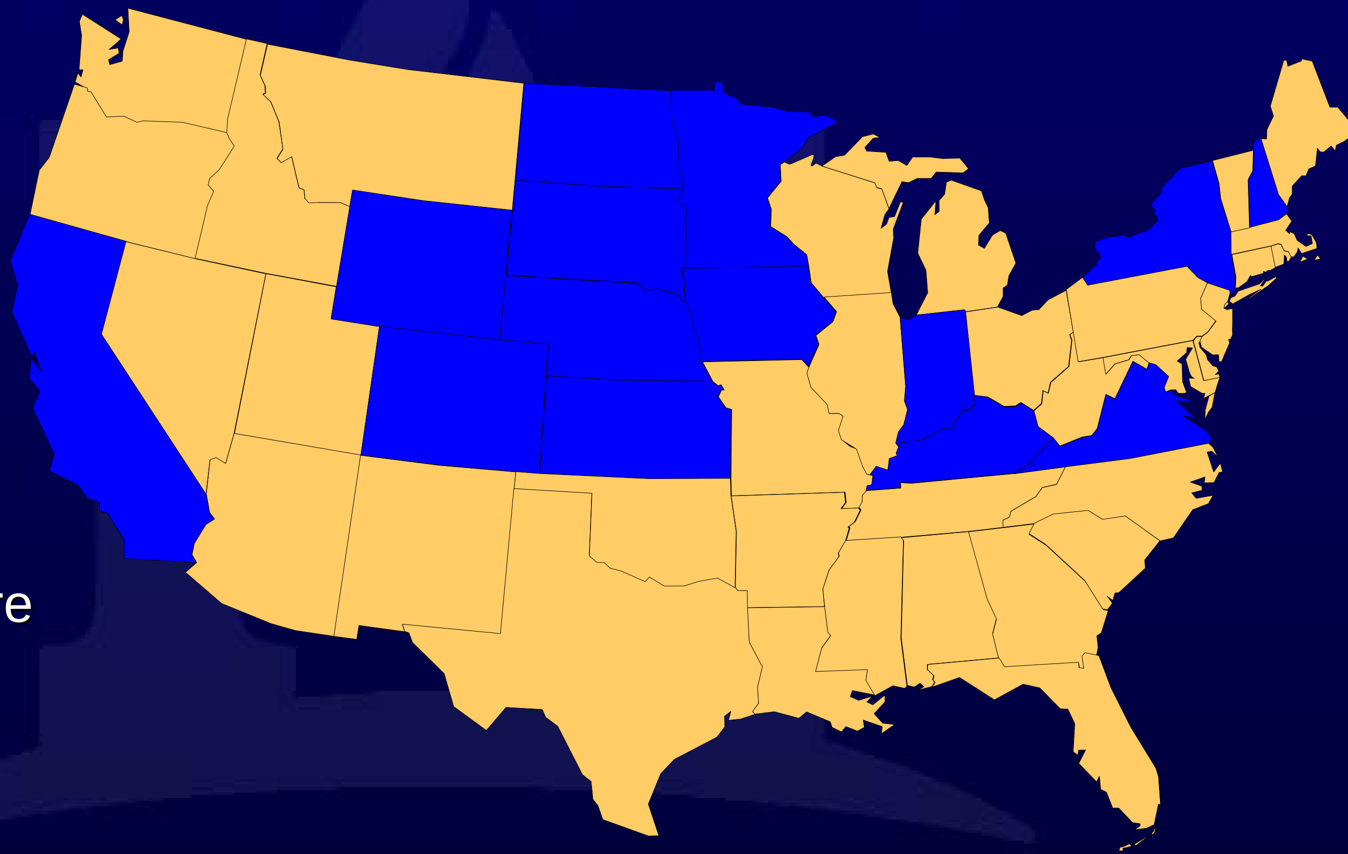
Pooled Fund Study Partners

- California
- Colorado
- Indiana
- Iowa
- Kansas
- Kentucky
- Minnesota
- Nebraska
- New Hampshire
- New York
- North Dakota
- South Dakota
- Virginia
- Wyoming



- Meridian Environmental Technology

Project Background

- Field tests have not examined economic benefits and costs of MDSS
- Project Objectives
  - Describe the essential functions of a winter MDSS
  - Describe the resources needed to supply the essential functions of an MDSS
  - Characterize and estimate the costs and benefits of deploying MDSS in state transportation departments

Essential Functions of MDSS

"A Tool"	"A Revolution"
Use MDSS Application 1 May Use MDSS Application 2	Rely on MDSS Application 1 Rely on MDSS Application 2

- Applications:
  1. Real-time assessment of current and future road weather conditions (Road)
  2. Real-time maintenance recommendations (Resources)
- Pooled Fund Study states' experiences lie generally between these levels

Tangible Benefits and Costs

	Agency	Motorist	Society
Benefits	• **Reduced materials use** • *Reduced labor costs* • *Reduced equipment & fuel use* • *Reduced fleet replacement costs* • *Reduced infrastructure damage*	• **Reduced motorist delay (through improved LOS)** • **Improved safety (through improved LOS)** • *Reduced response time* • *Reduced clearance time* • *Reduced vehicle corrosion*	• *Reduced environmental degradation*
Costs	• **Software and support** • **Communications** • **In-vehicle computer hardware** • **Training** • **Administration** • **Weather forecast provider**		

Bold – included in analysis
Italics – not included in analysis

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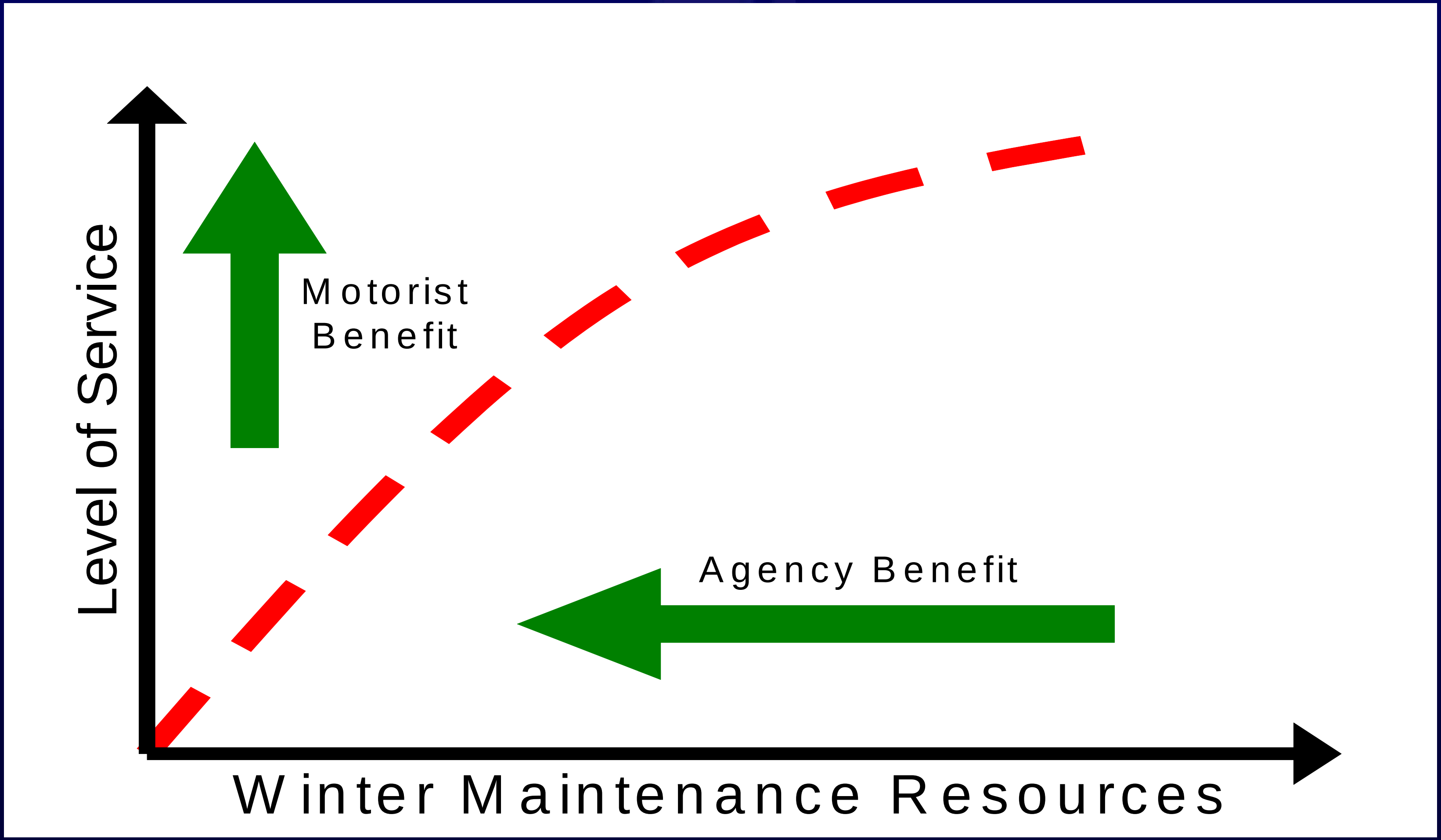
Benefit Tradeoff



Simulation Approach

- Use MDSS as analytic tool to predict future pavement conditions resulting from various maintenance actions
- Use MDSS outputs to compare the outcomes associated with different maintenance philosophies
- Incorporate risk factors to “dampen” potential benefits

Why Simulate?

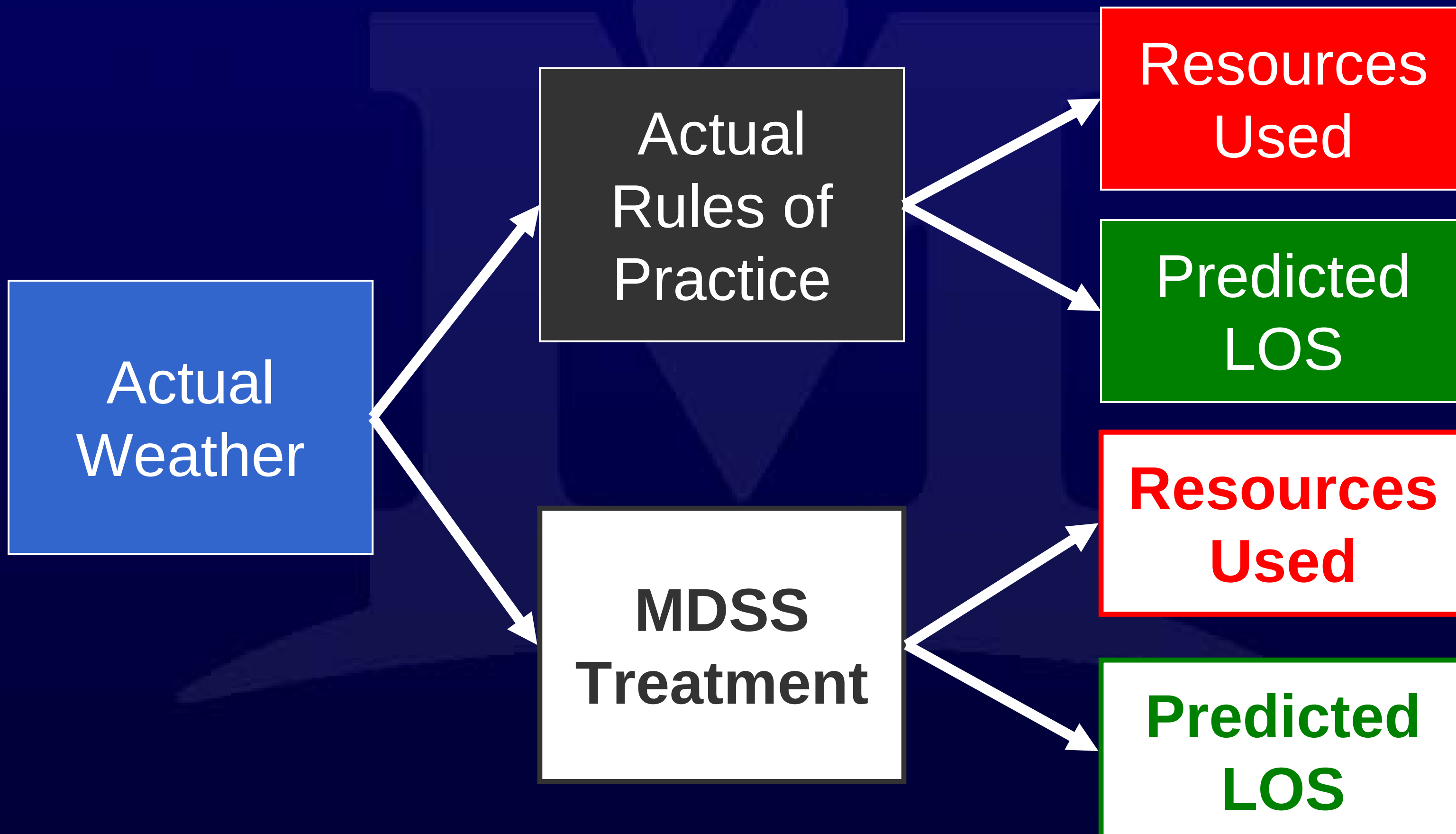
- Benefit-cost analysis must be quantifiable
- No PFS member state has adequate LOS data to measure tradeoff
- Simulator can generate objective and complete LOS data
- Simulation can allow for control of outside factors

Calibration

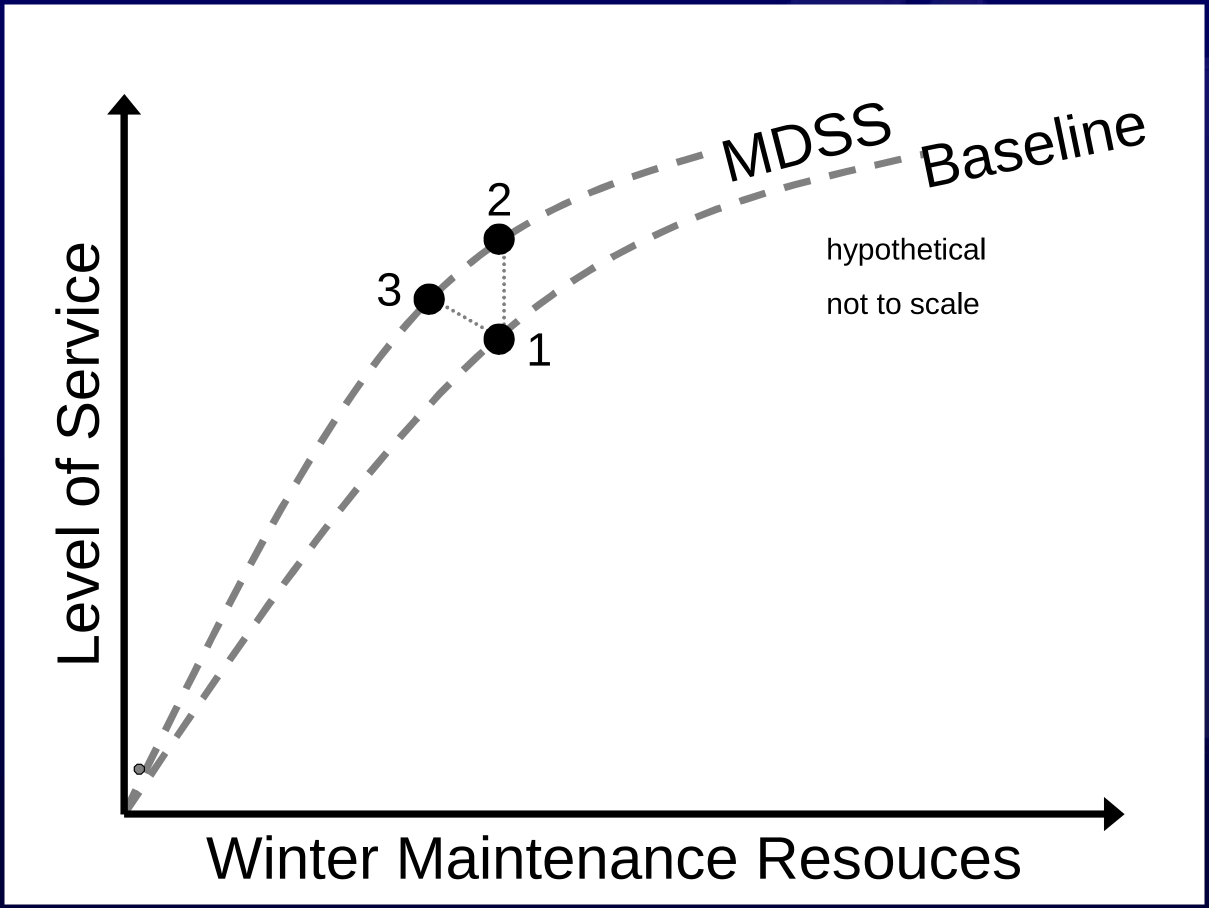
$$Resources = f\,(\,Rules\ of\ Practice,\ Weather\,)$$

Result: Actual Rules of Practice

Application of Calibrated Simulation



Points of Comparison



- Point 1: Calibration Point
- Point 2: Keep resources same
- Point 3: Keep triggers same

Case Studies

- Three states (CO, MN, NH)
  - Representative of different climates
  - Good historical data on maintenance practices
  - Capture variety of traffic and terrain conditions
- Simulate using several years of historic weather and maintenance data
  - Helps to “tune” MDSS and provide some validation
- Extrapolate to other routes in each state

Storm Classification

- Historical weather data from case study states
  - NH: 13 weather stations, including 150 winter seasons
  - CO: 29 weather stations (414 winter seasons)
  - MN: 60 weather stations (857 winter seasons)
- Over 30,000 storm events identified according to duration, precipitation amount and rate, air temperature range & trend, wind speed (before & after storm), condensation
- Storm events were classified using the K-means clustering method

Safety and Speed Adjustment Factors

- Crash rate and speed are affected by and vary with different pavement conditions
- Adjustment factors for crash rate and speed reduction were identified through literature review (> 30 past studies)
- Around 15 types of pavement conditions were used (e.g., day, wet, chemically wet, damp, lightly slushy,…)

MDSS Alternatives

- No implementation
  - Follow rules of practice
- Various levels of following recommendations
  - User acceptance
  - Technology (i.e. in-vehicle GUI)

If MDSS does not change the way that an agency performs winter maintenance (e.g. application material, rate, and timing), there would be no LOS benefit and no resource use benefit, so no <u>tangible</u> benefit would show up in this analysis

Costs

- Operational Infrastructure
  - Computers
  - Training
  - MDSS service
  - Agency IT support
- Supporting Infrastructure
  - Weather forecasts
  - RWIS
  - Bandwidth
  - Mobile Data Collection

Intangible Benefits

- Ability to portray information
- Training tool
- Improved documentation of actual maintenance activities
- Platform for future technology implementation

Findings: New Hampshire

SAVINGS	Resources		Delay	Safety	Total
Scenarios	(ton)	($M)	($M)	($M)	($M)
Same Condition	23,644	$1.182	$0.017	$1.168	$2.367
Same Resources	442	$0.022	$0.242	$2.622	$2.885
MDSS COSTS/YEAR		$0.333			
BENEFIT/COST		~ 8:1			

Findings: Minnesota & Colorado

Minnesota

- "Supercommuter" results similar to NH
- Rural commuter results variable, less distinct benefit
- Analysis is completing

Colorado

- Obtaining adequate weather data delayed analysis
- MDSS simulations have been performed
- Analysis is completing

Next Steps

- Complete Minnesota analysis
- Complete Colorado analysis
- Analyze intangible benefits
- Prepare final report (December 2008)
- Transportation Research Board Annual Meeting (paper submitted for January 2009 presentation)

Questions?

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