INTRODUCING THE NCHRP 15-49 IMPLEMENTATION GUIDE

15TH INTERNATIONAL CONFERENCE ON MANAGED LANES
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OVERVIEW OF NCHRP 15-49 RESEARCH

Develop *Guidelines for Implementing Managed Lanes*

- Draft is currently under NCHRP editor review

Phase II research studies:

- Roadway design decisions
- Lateral position of vehicles
- Practitioner preferences for geometric design tradeoffs
- Speed of vehicles in managed lane
- Access design study

Identify future research needs
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Phase II research studies:

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• Lateral position of vehicles (was in Session 8)
• Practitioner preferences for geometric design tradeoffs
• Speed of vehicles in managed lane
• Access design study (was in Session 7)

Identify future research needs
NCHRP 15-49 DELIVERABLES

**Guidelines**
Within NCHRP series
Available both hard copy and on web
Status = almost with NCHRP editors

**Research Report**
Description of research efforts
Available as a web-only document
Status = research team making final revisions
GUIDELINES FOR IMPLEMENTING MANAGED LANES

1. Introduction to Managed Lanes
2. Planning Considerations
3. Design Elements
4. Traffic Control Devices
5. Implementation and Deployment
6. Operations and Maintenance
7. Glossary
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INTRODUCTION CHAPTER
TOPICS

Orientation

• Legacy and growth trends

What’s New

• Changes in selected applications

Decision Making Experiences

• Challenges, opportunities and suggestions for practice
INTRODUCTION CHAPTER

LEGACY

Evolved from busways to HOV lanes to HOT lanes to express lanes

Federal policies initially encouraged moving person movement

1970-2015: Projects expand to 2500 miles in 11 states

MLs serve millions of trips and save over 600,000 hours of delay daily
INTRODUCTION CHAPTER

WHERE ARE MANAGED LANES?

Over 170 projects in 11 States + 3 Canadian provinces

Over 25 priced managed lanes with many in development
INTRODUCTION CHAPTER
WHAT’S NEW

Access design
Toll technology
Traffic control devices
Enforcement
INTRODUCTION CHAPTER

ACCESS: OPEN OR RESTRICTED

Restricted: simpler tolling, improved lane management, easier to enforce

More open: preferred by users, more costly, not concentrate weaves, helps transit

Combinations being applied

Orange Co, CA

Contra Costa Co, CA
INTRODUCTION CHAPTER
PYLONS

Soft barriers utilizing pylons are increasingly being applied to restrict access

I-10 Katy Tollway, Houston

SR 91, Orange Co, CA
INTRODUCTION CHAPTER, INCREASING ROLE OF ATM

HOT lane with lane controls and dynamic speed limits in Minneapolis

Source: MnDOT
Mature projects versus new capacity/construction projects. Guidance to date has focused on the latter.

Opportunities and challenges associated with P2 partnering and alternate project delivery.

Growing importance of financial feasibility.

Access plays a role in equity (it’s not just toll equity)

“Best” practices and regional consistency
INTRODUCTION CHAPTER
PARTNERING

Most projects involved multiple implementation/operation partners from diverse local/state agencies

- State DOTs
- Regional congestion management agencies
- Toll and transit providers
- MPOs
- Police
- Private concessionaires

Public-public partnering is common

Financing/funding often relies on partnering
INTRODUCTION CHAPTER
IMPLEMENTATION APPROACHES

Conversions

• Examples surveyed: I-85 Atlanta, I-680 and I-880 Bay Area, I-10 and I-110 Los Angeles, SR 167 San Diego
• Generally added tolling
• Typically represented operational changes
• Some were UPA/CRD grantees

New Construction

• Examples surveyed: I-75S/N Atlanta, I-635 and SH 183/I-820 Dallas-Ft Worth, I-15 San Diego, I-405 Seattle
• Followed standard project development process
• Most got sidetracked/delayed due to funding/financing
• Tested new financing and delivery approaches
INTRODUCTION CHAPTER
GUIDANCE FOR PRACTICE

For operational changes (conversions):

- Frame process around the scale of investment/impact
- Recognize the shorter improvement life cycle
- Apply appropriate metrics: goals/performance measures
- Recognize constraints, avoid project “creep”
- Legacy operation/design heavily influence outcomes

For new construction

- Financial feasibility plays big role in the project
- Expect many changes throughout the process
- Opportunities for partnering, transit treatments, D-B and P3s
- Outcomes must be a win-win for all corridor users
INTRODUCTION CHAPTER
GUIDANCE FOR PRACTICE

For all types of projects:

• Develop Concept of Operations early, involving all players
• Let regional policies develop from pilots; let standards of practice evolve based on lessons learned
• Schedule busters: funding, innovative procurements, toll system field testing
• Public outreach must be extensive and ongoing
• Equity is key for tolling/revenue and access
• Results must represent a win-win for all users
• Keep business rules and protocols simple with measurable outcomes
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PLANNING CHAPTER
OVERVIEW

Provides guidance for appropriate planning using experience from past projects and other guidance

• Planning and Programming
  • Goals and objectives
  • Corridor and regional planning
  • Conceptual feasibility
  • Funding and financing
  • NEPA, environmental review
  • Incorporating equity

• Policy and legislative considerations
  • Federal policies
  • State and regional policies

• Public Involvement and Support
  • Finding project champions
  • Engaging policy makers, media, public
PLANNING CHAPTER
CONCEPTUAL FEASIBILITY

Helps to evaluate alternatives through a defined lens, or framework

Implementation plan emerges based on findings, in concert with regional planning

- Institutional feasibility
- Design feasibility
- Operational feasibility
- Implementation feasibility
- Financial feasibility
- Public and political support
PLANNING CHAPTER
INCORPORATING EQUITY

Several dimensions requires different mitigation approaches

- Common perception about unjust burden on low-income and underrepresented groups

Access equity a particular concern

- Location of entry and exits have a sociological impact, local communities concerned about traffic bypassing businesses
- Creation of an access treatment plan to formalize partnership with the different markets abutting and using facility

Source: Battelle Memorial Institute with information from U.S. Census and Google Maps

Median Household Income near I-10 and I-110 Metro ExpressLanes in Los Angeles
PLANNING CHAPTER
ENVIRONMENTAL REVIEW

Environmental review mandated if project involves use of Federal-aid funding or alters previous commitments

NEPA not required for:

• Camera installations, access treatments, changes in separation type, or changes in operational policy (2+ to 3+ carpools)

Challenge is timing and coordination

• Planning and linkage (PEL) studies can be used to reduce duplication between agencies and improve flow of information

Applied for specific projects or general corridor analysis

• Design typically done at a 30% preliminary level
Sponsors be flexible to adapt to changes in financial support

Revenue generated can be small or large

- SR 167 HOT Lanes (Washington State)
  - FY2015 net tolling revenue: $1.67 million
  - FY2015 excess revenue (after expenditures): $904,680
- North Tarrant Express (Texas), I-820 and SH 121/183
  - 52-year agreement with private concessionaire
  - $2.05 billion to construct
  - First year: $43 million in net revenue
PLANNING CHAPTER
TRAFFIC AND REVENUE FORECASTING

For priced facilities, T&R studies assess ability to manage demand and raise revenue

Different from NEPA-style forecasts

- Investment-grade assumptions and values not appropriate for NEPA
- T&R results tend to be more conservative
- Provide explanation to the public for differences in NEPA vs. investment forecasts

Other guidance

- Using a single value of time is limiting since willingness-to-pay varies across an entire population
- Value of time not solely dependent on traffic, can be influenced by seasonal demand, school schedules, and radio reports
- Forming a peer review group is helpful to test assumptions
HELPFUL ENGAGEMENT TECHNIQUES

Outreach can be separate from NEPA
- Defining terms and describing concept
  Should lead to managed expectations
- Should be done during all project delivery steps

Use market research to understand users
- Tie findings to the objectives for the project

Finding a project champion
- Champion could be an elected official, community leader, or individual from private sector
- Helpful to have someone not from transportation sector

Citizen Advisory Committee/Community Task Force
- Engaging stakeholders through a more formal body
Original goals could change after project opening

- Shifting user perceptions

Impact of maximum toll price limit and/or occupancy status

- Mitigates some equity concern, but restricts ability to manage congestion

Contrasting revenue vs. throughput goals

- Not the same goal!
- Facilities can generate more revenue by charging higher prices for fewer users

Effective messaging

- Saying that users can “but their way out of congestion” does not work
- If tolls exist, and reducing congestion is a goal, then explain how pricing actively manages congestion
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IMPLEMENTATION & DEPLOYMENT (I&D) CHAPTER, OVERVIEW

Provides guidance for design, installation, and delivery of system related components

- Design review / configuration management
- Scheduling, installation, testing, and acceptance
- Toll collection system considerations
- Upgrades and expansions
- Project delivery
I&D CHAPTER, STRUCTURING THE DESIGN PROCESS

Issue:

- Managed lanes are complex systems installed by disconnected entities
- Handoffs
  - Civil contractor
  - Toll systems integrator
- Example
  - Contractor installs power to common utility panel
  - Integrator pulls power to toll collection equipment
  - Contractor ties panel to utility cabinet with multiple points of access
I&D CHAPTER, STRUCTURING THE DESIGN PROCESS

Guidance:

• Use configuration management for design review process
  • Highlights points of demarcation
  • Identifies gaps / overlaps in separate contracts
  • Full requirements reflected in final design specifications as only consolidated document
  • Positive affirmation: readiness before deployment

“Configuration Management verifies that a system performs as intended, and is identified and documented in sufficient detail to support its projected life cycle.”
I&D CHAPTER, DEPLOYING TOLL COLLECTION SYSTEM

Issue:

• Combination of off-the-shelf equipment with customization of software, integration, and procedures
• Integrator timing is highly dependent upon…
  • Physical availability of facility
  • Administrative constraints (client staffing, funding, legislation)
• Coordination with comprehensive stakeholders
• Visible connection to project
  • Signs, gantries, cameras, and readers make the project more tangible to the public

Source: WSP | Parsons Brinckerhoff
I&D CHAPTER, DEPLOYING TOLL COLLECTION SYSTEM

Guidance:

- Emphasis upon the systems engineering process for transportation operations
- Detailed task schedules (initial review, gap analysis, preliminary / final design, integration, testing, and deployment)
- Best practices
  - Maximize use of proven designs
  - Minimize development of new software
  - Determine phasing for additional system features
  - Iterative process with multiple internal peer reviews / tests

Source: WSP | Parsons Brinckerhoff
I&D CHAPTER
DETERMINING PROJECT DELIVERY

Issue:

• Establishment of separate and distinct work elements:
  • Civil construction
  • Toll system integration
  • Tolling operations and maintenance

• Separate and distinct delivery components
  • Design – bid – build
  • Design – build
  • Design – build – operate – maintain
  • Design – build – finance – operate – maintain
## I&D Chapter
### Determining Project Delivery

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<th>Procurement</th>
<th>Best For...</th>
<th>Concerns...</th>
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<td><strong>Design-Bid-Build</strong></td>
<td>• Small-scale projects</td>
<td>• Schedule length</td>
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<td></td>
<td>• Minimum-risk projects</td>
<td>• Risk is on agency</td>
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<tr>
<td><strong>Design-Build</strong></td>
<td>• Cost efficiencies</td>
<td>• Less control over design</td>
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<td></td>
<td>• Single point of responsibility</td>
<td>• Responsive decision-making</td>
</tr>
<tr>
<td><strong>Design-Build-Operate-Maintain</strong></td>
<td>• Lower life-cycle costs</td>
<td>• Defined performance requirements</td>
</tr>
<tr>
<td><strong>Design-Build-Finance-Operate-Maintain</strong></td>
<td>• Revenue and funding</td>
<td>• No control over design.</td>
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<td></td>
<td>• Risk to private sector.</td>
<td>• Greater political risk.</td>
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<td></td>
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<td>• Expertise in finance</td>
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DESIGN CHAPTER
OVERVIEW

Focus on issues a designer considers in designing a managed lanes facility (cross-references to other chapters, and references to external sources)

Key topics:

• Design considerations for specific user groups
• Geometric design considerations
  • Consistency
  • Recommended values for specific elements
  • Issues related to HOV-to-HOT conversion
• Access considerations
  • Placement of managed lanes
  • Separation treatments
  • Access design and location
• Operational impacts
DESIGN CHAPTER
CONSIDERATIONS FOR USER GROUPS

Design vehicle/eligibility

- Intended users
- Design characteristics

Transit considerations

- Design vehicle considerations
- Location of transit facilities

Truck considerations

Source: Kay Fitzpatrick
DESIGN CHAPTER
DESIGN CONSIDERATIONS

Key topics:

- Consistency
- Design speed
- Cross-section and alignment
- ML orientation with GP lanes

- Separation between ML and GP lanes
- Reversible lanes
- Contraflow lanes
- Pullouts (enforcement / refuge)
- HOV-to-HOT conversion

Source: Marcus Brewer
DESIGN CHAPTER
CONSISTENCY

Key topics:

• System integration
• Local, regional, and state guidelines
• National guidelines
• Design variances and flexible design philosophies
DESIGN CHAPTER
ELEMENTS

Key topics:

• Design speed
• Cross-sectional elements
• Operational effects of cross-section
  • Weather
  • Special events
  • Enforcement
  • Maintenance

Source: WSP | Parsons Brinckerhoff
DESIGN CHAPTER

CONTEXT OF GP LANES

ML orientation with respect to GP lanes

- Location of ML compared to median
- Part-time shoulder use (DSU)
- Consideration of contraflow

Separation between ML and GP lanes

- Barrier, buffer, pylon, pavement markings

Source: Marcus Brewer
DESIGN CHAPTER
ADDITIONAL FEATURES

Reversible lanes
Contraflow lanes
Enforcement pullouts
Refuge pullouts

Source: TTI

Source: Beverly Kuhn
DESIGN CHAPTER, ISSUES: HOV-TO-HOT CONVERSION

General design considerations

Accommodating toll collection and enforcement

Access control and separation

Source: Adapted from Perez and Sciara (2003)
DESIGN CHAPTER
ACCESS CONSIDERATIONS

Limited versus continuous
Continuous-access considerations
Frequency of limited-access points
Treatment for beginning a ML
Intermediate access
  • Weave zones/weave lanes
  • Auxiliary lanes
  • Direct access
Treatment for ending a ML
(Covered in greater detail in Session 7)

Source: Darren Henderson
DESIGN CHAPTER, OPERATIONAL IMPACTS ON DESIGN

Tolling systems

- Selection of tolling system
- Providing for appropriate infrastructure, equipment, and devices

Enforcement systems

Incident management

Capacity

Drainage and hydraulic needs

Source: Chuck Fuhs
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TRAFFIC CONTROL DEVICE (TCD) CHAPTER PURPOSE

How to find relevant MUTCD sections

How to apply general MUTCD principles to new designs and operations

Identify needed research

2009 MUTCD Contains new Chapter 2G on Preferential Lanes but information is diffused throughout

Source: FHWA
TCD CHAPTER
OVERVIEW

TCD Definitions and general sign design
Guide and Regulatory Signs
Changeable Message Signs
Lane Use Control Signals
Reversible and Contraflow Lane TCDs
Pavement Markings
Other Information Dissemination Methods
Installation and Maintenance
Trade-offs in Constrained Designs
TCD CHAPTER
MUTCD TERMS

Preferential Lane

Priced Lane
All users pay all of the time 24/7 or fixed schedule

HOV Lane
Bus/Truck-Only Lane
No charge, 24/7 or fixed schedule

Managed Lane
Changes in response to current conditions

Express Lane
Priced managed lane; can include HOT lanes
TCD CHAPTER
GENERAL SIGN DESIGN RESOURCES

MUTCD applies to any road open to public travel

Your state may have its own MUTCD

Standard Highway Signs has detailed layouts

Chapter 2F Toll Roads contains lots of relevant information

Check the Federal MUTCD website for interim approvals and interpretations
TCD CHAPTER
IMPORTANT GENERAL INFORMATION

Use a purple background on ETC payment panel only when registered ETC accounts are required.

If video tolling is in place, purple is not required.

Pylons are not considered TCDs in this application.

Roadside signs may not display internet addresses or phone numbers greater than 4 digits.

Source: FHWA MUTCD
Chapter includes considerations for surface street access points

Driver information overload is a concern

Violations of driver expectancy in access design (e.g. left entrances, long collector roads) is a concern

Interchange sequence signs may help

Source: FHWA MUTCD
TCD CHAPTER
OTHER COMMUNICATION METHODS

Local Media outlets

Virtual Drive-throughs used at public meetings and on websites

Billing inserts or websites

Apps

Source: DriveOnTexpress.com
TCD CHAPTER
RESEARCH GAPS IDENTIFIED

Need for similar guide for arterial managed lanes
Public outreach, marketing guidance
Use of terms to describe facility types

Source: Washington's Top News wtop.com
TCD CHAPTER
RESEARCH GAPS IDENTIFIED (2)

Sign sequencing and priority

- “what is the highest to lowest level of information needed?”

Amount and type of information presented to motorists on one structure

Specific sign legends

- Pay by plate, Pay by Mail, Bill by Mail
- Express Lanes term comprehension
- HOV Symbols
TCD CHAPTER
RESEARCH GAPS IDENTIFIED (3)

Exit Numbering

Pavement Markings

• Access areas
• In-pavement lighting
• Pull-through pavement markings associated with left-side ramps

TCDs for Reversible Lanes

Toll rates
TCD CHAPTER
EMERGING ISSUES & OPPORTUNITIES

Provision of comparative travel time information

Communicating managed lane network connections

Transponder and in-vehicle technologies
TCD CHAPTER
LESSONS LEARNED

You can’t sign your way out of a bad design
You can’t sign your way out of a bad operational strategy
TCDs cannot be your only form of communicating with users
The Managed Lanes TCDs must work in concert with general purpose TCDs.
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OPERATIONS AND MAINTENANCE (O&M) CHAPTER, OVERVIEW

Provides guidance for desired characteristics, components, and requirements for the long-term function of managed lanes systems

- Concept of Operations
- Consideration for Toll Operations
- High Occupancy Vehicle Eligibility Considerations
- Ongoing Operations
- Startup / Opening of Facility
- Business Rules
- System Operations
- Performance Monitoring / Evaluation
- Maintenance
**O&M CHAPTER, MANAGED LANES**

**CONCEPTS OF OPERATIONS**

**Issue:**

- Define design elements and operating parameters for policy establishment, stakeholder concurrence, and business rule development
- Address key questions…
  - **Who** are the stakeholders and users of the system?
  - **What** are the elements and capabilities of the system?
  - **Where** is the affected system?
  - **When** will activities be performed?
  - **Why** is the strategy being used?
  - **How** will the system be operated and maintained?
O&M CHAPTER, MANAGED LANES
CONCEPTS OF OPERATIONS

Guidance:

• Use Systems Engineering Process for developing concepts of operations
• Regional network concept of operations
  • Address policy and operational concepts for system on whole
• Corridor concept of operations
  • Preliminary ConOps – establish guidance during conceptual design
  • Final ConOps – confirm parameters that serve basis for ongoing operations and maintenance
O&M CHAPTER, TOLL COLLECTION CONSIDERATIONS

Issue:

- Congestion pricing is a critical component towards the development, implementation, and operation of successful priced managed lanes.
  - MAP-21 / FAST Act mainstreamed priced managed lanes
  - Variable pricing is mandated to ensure performance is maintained
  - Limited guidance is currently available on how to choose between pricing systems
O&M CHAPTER, TOLL COLLECTION CONSIDERATIONS

Guidance:

Enhance Lane Efficiency and Utilization
- Expand use of capacity in underutilized lanes
- Efficiently allocate capacity in overutilized lanes

Provide Travel Travel Time Reliability
- Maintain reliable speeds
- Sustain unimpeded travel for transit

Yield Revenue to Offset Lifecycle Costs
- Enhance financial resources for new capacity
- Sustainable compensation for long-term O&M costs
Guidance:

- Simplicity.
  - Easy to understand and use by the traveling public
- Effectiveness.
  - Optimization of person and goods throughput, vehicular speed reliability, travel time performance, revenue generation, and/or providing priority for transit and HOV.
- Flexibility.
  - Scale to accommodate multiple interconnected facilities
- Integration.
  - Integrate with complementary operational treatments
O&M CHAPTER, TOLL COLLECTION CONSIDERATIONS

System of Pricing

- Dynamic Pricing
- Time of Day Pricing
- Hybrid Pricing

October 12, 2015
O&M CHAPTER, HIGH OCCUPANCY VEHICLE ENFORCEMENT

Issue:

• Validation and enforcement of HOV customers is key to maintaining managed lane performance
  • Desired operation of the facility is jeopardized
  • Violation rates of greater than 50 percent in extreme
• Occupancy enforcement remains a primarily manual process.

Source: WSP | Parsons Brinckerhoff
## O&M CHAPTER, HIGH OCCUPANCY VEHICLE ENFORCEMENT

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<th>Declaration mechanism</th>
<th>Pros</th>
<th>Cons</th>
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</thead>
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<tr>
<td>Switchable transponder</td>
<td>• Simple communication</td>
<td>• Costly device</td>
</tr>
<tr>
<td></td>
<td>• Easy to use</td>
<td>• Willful violators</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Driver distraction</td>
</tr>
<tr>
<td>Account declaration</td>
<td>• Inexpensive</td>
<td>• Cumbersome</td>
</tr>
<tr>
<td></td>
<td>• No capital</td>
<td>• Inadvertent violators</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Driver distraction</td>
</tr>
<tr>
<td>Declaration lane</td>
<td>• Simple for the driver</td>
<td>• Expensive</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Permanent</td>
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### O&M CHAPTER, HIGH OCCUPANCY VEHICLE ENFORCEMENT

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<th>Enforcement Mechanisms</th>
<th>Pros</th>
<th>Cons</th>
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<tr>
<td>Toll paying vehicles only</td>
<td>• Simple</td>
<td>• No HOV incentive</td>
</tr>
<tr>
<td></td>
<td>• Easy enforcement</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Greatest revenue</td>
<td></td>
</tr>
<tr>
<td>Declaration with in-field validation</td>
<td>• Common practice</td>
<td>• Enforcement required</td>
</tr>
<tr>
<td></td>
<td>• Mature technology</td>
<td>• Difficult to validate</td>
</tr>
<tr>
<td>Mobile enforcement</td>
<td>• No enforcement zones</td>
<td>• Enforcement required</td>
</tr>
<tr>
<td></td>
<td>• No need for separation</td>
<td>• Cumbersome interface</td>
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