COLORADO
Department of Transportation

# INNOVATIVE TRANSPORTATION INFRASTRUTURE ALTERNATIVES

## Rapid Speed Travel Studies

**Background**

The Colorado Department of Transportation is interested in next generation mobility and looks to conduct feasibility studies in partnership with different technologists to assess the feasibility of innovative transportation infrastructure alternatives (defined currently as Rapid Speed Travel Studies (RSTS), assessing the policy and regulatory implications of this potential new form of infrastructure, the economic and value capture of the technology, the application and impacts of specific route planning and how the technology would facilitate the movement of people and goods in the state of Colorado.

**Elements of the RSTS**

The Rapid Speed Travel Studies will consist of two primary components:

1. State Benefits and Opportunities Study
2. Technologist Feasibility Analysis and potential Project Development Plan for a given mode of transport (could be multiple partners)

These components will be complementary and potentially interlaced with each other as the state funded Benefits and Opportunities Study includes the baseline conclusions, assumptions, definitions and data that will be shared during development with the specific technologist feasibility analysis. The technologist feasibility analysis will include information on technology, routes and other assumptions that will be shared during development as appropriate with the State Benefits and Opportunities Study. The feasibility analysis be funded and supported by each technologist through a public private partnership and consequently some elements may be deemed as confidential and proprietary.

*Notes: CDOT is moving forward with two concurrent Technologist Feasibility Studies (Hyperloop One and Arrivo). Both will be conducted by AECOM. During*

*this process, AECOM will produce a separate feasibility study for the state either based on the work conducted for the technologists feasibility analysis or based on additional work just for CDOT. Additionally, CDOT and AECOM are reaching out to other states to examine the possibility of a pooled research/feasibility study to created baseline assumptions and processes for super speed travel.*

## State Benefits and Opportunities Study

### Objective

Building on previous studies and new advances in technology, the State Benefits and Opportunities Study seeks to determine if rapid speed transport can be built and should be constructed, operated, and maintained. As a public agency, CDOT has a mission to provide safe and reliable transportation to the travelers of Colorado. Rapid speed travel is a new and emerging technology that should be considered as a possible innovative transportation option for both freight and passengers. The State Benefits and Opportunities Study will examine increasing populations and traffic statewide and assess whether rapid speed travel is a possible approach to addressing congestion and future transportation needs. The study will also build upon existing high speed travel studies already conducted including the Interregional Connectivity Study (ICS) which addressed the Front Range and the Advanced Guideway System Technology and Financial Feasibility Studies which addressed the I-70 Mountain Corridor. Knowing that new technologies are emerging on a rapid basis, this study with will be a living document and updated as new technologies emerge.

The State Benefits and Opportunities Study will address the following areas:

### Purpose and Need

Define the purpose and need. Initial definition includes:

#### Purpose

The purpose of State Benefits and Opportunities Study is to:

- Provide Colorado with a well-supported framework for rapid speed regional transportation
- Ascertain the state-wide social, environmental, and economic benefit and costs of implementing super speed travel
- Assess feasibility of public private partnerships on super speed travel infrastructure ventures

#### Need

The State Benefits and Opportunities Study is needed to present potential solutions to the following needs:

- Address the mobility demands of future population growth
- Improve mobility and system capacity through provision of an additional travel option
- Enhance economic growth and development through improved connectivity
- Offer fast, reliable transportation for freight and passengers

- *NOTES: The goal of the State Feasibility Study (and which will be reflected in the technologists feasibility analysis) is to test baseline assumptions on different policy, regulatory, environmental scenarios. CDOT will use these assumptions to engage with others states, USDOT, FHWA, FTA, FRA and others in next step discussions about super speed travel.*

**Policy**

Define the overall answer the following questions:

- Which agency will oversee and regulate this new technology? *Assumption: At the federal level, will create a new oversight process that originates with FHWA and with concurrence with FTA and FRA. At state level, CDOT will play lead in initial process, following FHWA, FTA and FRA guidance.*
- What governance structure will apply? *Assumption: There will be a new governance structure at the state level that oversees the implementation of infrastructure (examples: E470, Calfornia Transportation which is outside of CalTrans, etc.) Assumption: The new agency will have eminent domain powers.*
- Which environmental approval processes will be applied? *Assumption: CDOT will establish an environmental approval process following FHWA guidelines, with addition of applicable FTA guidelines. CDOT will present this new approval process to USDOT (and with other states and agencies) as draft process.*
- Determine what CDOT's and private partner's role in ownership, construction, operations, maintenance, and funding will be? *Assumptions:*
    a. *Ownership #1 - Greenfield Build: CDOT/Government entity owns land and leases to private partner. Ownership includes below grade, at grade and above grade (air rights).*
    b. *Ownership #2 -- Greenfield Build: No ownership, treat as if were pipeline construction.*
    c. *Ownership - Along Existing ROW: CDOT/Government entity owns land (discussion about ownership of infrastructure)*
    d. *Construction - CDOT provides quality review and assessment of construction as potential governance entity.*
    e. *Operations -- Private partner operates system.*
    f. *Maintenance - Private partner maintains transportation asset.*
- How does super speed travel impact existing land use plans? *Assumption: CDOT and regional planning partners integrate super speed travel into upcoming transportation/land use/vision plans.*

- While individual technologists may define specific beginning routes, how would the answers to the above questions change for a larger network?

**Transportation Demand and Economic Benefit Analysis**

Evaluate the overall transportation demand for rapid speed travel, beginning with the Front Range including assessment of transportation benefits, economic benefits, transportation demand modeling, land use.

Transportation Benefits

- Congestion reduction
- Emissions reduction
- Time savings
- Crash reduction

Economic Benefits

- Agglomeration
- Supply chain integration
- Productivity increases
- Social benefits

Transportation Demand Modeling

- Demand, ridership, freight volume
- Define catchment sizes for existing cities, towns and other key nodes on the corridor
- Analyze current passenger travel patterns along potential routes including possible station locations, including peak flow times
- Analyze current cargo travel patterns along potential routes including possible station locations, including peak flow times and typical mode and method (container type) of shipments
- Analyze current modes of transport on corridor, journey times, ridership
- Estimate induced demand based on readily available methods of estimating mode-shift and growth models

- Project potential future flows, e.g. new commuter flows, new tourism traffics, new cargo flow
- *Note: Traffic and Revenue Analysis will be conducted in technologist feasibility analysis*

Land Use

- Land use/growth scenarios around potential routes and possible station locations including potential for transportation oriented development and value capture.

*Notes: CDOT will use the ICS and AGS studies as baseline for this analysis. The work done in the technologists feasibility analysis will feed the broader state analysis (and may vary pending the technology impacts)*

**Technology Assessment**

Conduct an overall assessment of various rapid speed technologies to gain clarity on the core capabilities and focused application of the technology within Colorado.

- Core capabilities and what the system is best suited to provide in the Colorado context
- System capacity capabilities
- Technology footprint and geometry
- Station requirements and footprint
- System power and communication requirements
- Alignment and operating speed requirements
- Safety assessment/certification of the system
- Order-of-magnitude capital construction costs
- Order-of-magnitude operational costs
- Construction and assembly duration estimates

*Assumption: Federal government will be responsible for safety certification. State government/ government entity will be responsible for validating system performance (see CO Autonomous Working Group Charter and Safety Certification Checklist).*

**Environmental Analysis**

Conduct an assessment of potential implementation scenarios. Analysis includes review of alignment, technology, maintenance, operations and cost.

*Note: Complete route analysis will be conduct in technologist feasibility analysis*

- Visualizations of stations and alignment for possible route(s)
- Station layout, footprint, and required infrastructure
- Connectivity and user demand
- Right-of-way preliminary analysis (including assessment of below, at and above ground property rights)
- Environmental impacts
- Updated rough-order-magnitude cost analysis

*Assumption: Environmental concepts will create analysis based on several different typology/technology scenarios:*

a. *Super speed on "open" existing CDOT/Gov Agency ROW*
b. *Super speed on "built" existing CDOT/Gov Agency ROW*
c. *Super speed on green field*
d. *High/super speed on "open" existing CDOT/Gov Agency ROW*
e. *High/super speed on "built" existing CDOT/Gov Agency ROW*
f. *High/super speed on green field*

**Regulatory Framework**

Explore the potential environmental processes.

- Applicability of existing Colorado studies and/or new or existing environmental clearance process
- Identify preferred environmental clearance process
- Identify agency role in the safety certification process
- Identify entitlements and permits required
- Provide an overview of the environmental and entitlement process
- Determine agencies that would have jurisdiction and/or permitting authority
- Identifying other key stakeholders and/or community groups
- Identifying the steps needed to implement the projects
- Identifying the structure and supporting policy of the implementing agencies

*Assumption: Because of the varying elements in the different technologies, CDOT will establish an environmental approval process following FHWA guidelines, with addition of applicable FTA guidelines.*

*Notes: CDOT would like to coordinate with other states where appropriate but believe that we could present this hybrid process to USDOT for consideration as an initial framework for environmental approval.*

Explore the potential safety certifications.

- Applicability of existing Colorado infrastructure (rail, pipeline, other) for possible certification process
- Identify agency role in the safety certification process
- Identify certifications and permits required
- Provide an overview of the environmental and entitlement process
- Determine agencies that would have jurisdiction and/or permitting authority
- Identifying other key stakeholders and/or community groups
- Identifying the steps needed to implement the projects
- Identifying the structure and supporting policy of the implementing agencies

*Notes: CDOT assumes that the federal government will be responsible for the safety certification of super speed travel following FTA, FRA or even FAA standards. If this process follows the advances in technology policy similar to autonomous vehicles, the federal government may establish a safety self-certification process and then validate that process. One could also look to ISO 14000 and 14001 as a self-certification process. Areas for research include the European standards for high speed travel, consideration of what is the standard for safety. Will there be a different standard for cargo versus passenger, how do you define safety versus comfort. Additionally, which safety tolerance standard will be used for this technology: highway, airline, rail?*

**Implementation Strategy**

Explore the potential implementation strategies including next steps for potential policy decisions including:

- Determine role of agency in overall implementation
- Assess who owns the infrastructure
- Assess who constructs the infrastructure
- Assess who operates the infrastructure
- Assess who maintains the infrastructure
- Coordinate with the High Performance Transportation Enterprise to determine the potential construct of P3 as a delivery mechanism
- *Note: Technologist feasibility analysis will detail specific Project Development Plan*

*Notes: Based on the assumptions' stress test results, we think it's important to lay out the next steps for how we would move forward on those policy decisions. For instance, if we determine a new governance structure is needed for a particular project, what are the next steps to implement. Can we link certain actions and define what needs to happen first before we can move to the next step. What kind of investigation is necessary for public private partnerships, etc.*

**Stakeholder and Public Engagement**

Develop a tiered stakeholder and public engagement process as appropriate.

*Notes: CDOT will play the lead role in stakeholder involvement. However, CDOT and the technologists can independently solicit additional stakeholders to engage in the feasibility study, including solicitation for financial sponsorship into the partnership.*

## Technologist Feasibility Analysis

### Objective

The goal of the Technologist Feasibility Analysis is to evaluate their specific technology and the feasibility of its operations in Colorado along a specific route(s). The study will identify individual long term opportunities for the technology to be integrated into the region based on the proposed performance of the technology including the high-level potential system layout. The study will include potential tailored economic impacts, value capture and traffic and revenue modeling. The stud(ies) will be customized per technologists intent and direction and could include:

### Summary of Study Area and Background

To provide a baseline for the improvements and impacts technology can have on the region in anticipated configuration.

- Description of region including
    - Existing and planned transportation systems
    - Major population centers and general traffic patterns
    - Future growth and development anticipated
    - Business background and growth
- Region transportation needs
- Other intermodal background and future developments
- Transportation opportunities
- Connectivity with other transportation modes
- Available space/rights of way

### Technologist Specific Basis of Design

Develop a basis of design that will outline the proposed performance of the technology, the capabilities of the system's performance, and the requirements required to build and operate the technology. The following will be included in the basis of design:

- Technology description including system-level, product-level, and component level descriptions
- Technology key specifications for preliminary analysis
    - Required right of way
    - Required infrastructure (Built Infrastructure and power infrastructure)
    - Operational model- loading and stations
    - Guideway specifications
    - Integration with existing infrastructure (intermodal centers, crossings, etc.)

    - Integration with other commercial assets
    - System requirements (operational speeds, headways, throughput)
    - Life cycle of system components
- Operational description of the system
- Safety assessment/certification of the system

**Route Assessment and Infrastructure Planning/Impact Analysis**

Identify and conduct preliminary analysis and design of possible routes.

- Right-of-way preliminary analysis
- Environmental
- Connectivity and user demand
- Updated rough-order-magnitude cost analysis
- Station layout, footprint, and required infrastructure
- Visualizations of stations and alignment for preferred route
- Preliminary design drawings
- Infrastructure and civil analysis of required construction and improvements
- Integration with other intermodal or commercial assets
- Airport integration analysis (passenger and freight)
- Stations points and route analysis
- Cross section for proposed routes
- Connectivity into existing and planned transit and scalability analysis
- Analysis of longitudinal infrastructure including ROM cost, environmental impacts and required construction footprint
- Constructability

Risk analysis including identification of physical constraints, environmental risks, and potential conflicts that could limit feasibility of the technology's integration

**System Visioning and Assessment**

Assess long term technology implementation routes and potential network design will be further studied.

- Identification of potential stations and infrastructure required including maintenance facilities and power stations
- Top level assessment of the potential systems risks and benefits to the region

**Preliminary Operations Plan**

Establish a preliminary concept of operations plan will be developed for the route.

- Outline preliminary operations and safety requirements of non-passenger system
- Plan for cargo and passenger travel
- Preliminary cargo/passenger operational model, loading/station operations, and passenger safety
- Intermodal/commercial integration operations model

**Demand/Market Analysis**

Estimate the demand and market of the system.

- Demand, ridership, freight volume, and high level revenue potential
- Targeted use case analysis of the route and endpoints
- Origins and destinations study around endpoints
- Engagement of potential regional business partners

**Stakeholder Identification and Implementation Plan**

Determine an implementation strategy for the technology. The long term vision will also be considered in this analysis for potential continuity between the two visions.

- Analyze regulatory and safety framework and analysis
- Identify preliminary environmental and permitting process
- Provide overview of the environmental and entitlement process
- List agencies that would have jurisdiction and/or permitting authority
- Identify other key stakeholders and/or community groups
- Identify the steps needed to implement the project
- Identify the economic model and financial strategies to implement the project
- Outreach to key stakeholders
- Potential financial partners

**Project Analysis**

Summarize the technology feasibility by discussing and creating a next-step strategy.

- Determine project's preliminary technical and financial feasibility
- Implementation plan and strategy
- Develop next steps for project, if feasible
- Identify potential partners and stakeholders for engagement