Integrated Corridor Management

Concept Development and Foundational Research

Technical Memorandum

Task 3.2 – Develop Criteria for Delineating a Corridor

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16. Abstract

Task 3 involves overall foundational research to further the understanding of various aspects of Integrated Corridor Management (ICM) and to identify integration issues needed to evaluate the feasibility of the ICM initiative. The focus of Task 3.2 and the purpose of this document (TM 3.2) to "develop criteria for delineating the boundaries of a corridor and possible approaches/methodologies for using the criteria to identify the boundaries of a corridor and corresponding issues."

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Integrated Corridor Management (ICM)
Technical Memorandum

Task 3.2 – Develop Criteria for Delineating a Corridor

TASK OBJECTIVE

Task 3 involves overall foundational research to further the understanding of various aspects of Integrated Corridor Management (ICM) and to identify integration issues needed to evaluate the feasibility of the ICM initiative. The focus of Task 3.2 and the purpose of this document (TM 3.2) is to "develop criteria for delineating the boundaries of a corridor and possible approaches/methodologies for using the criteria to identify the boundaries of a corridor and corresponding issues."

BACKGROUND

The American Heritage Directory defines "criteria" as a "standard, rule, or test on which a judgment or decision can be based." In the context of ICM, this term is something of a misnomer. The range and variability of potential corridor characteristics – operational, institutional, technical, and the physical layout of corridor networks – is so vast that there can be very few hard and fast rules concerning the delineation of corridor boundaries. Rather, there are several guidelines and concepts – mostly operational and physical in nature – that need to be considered (i.e., "judgment") by the stakeholders when determining corridor boundaries. Moreover, corridor boundaries may not even be fixed – the size of a corridor may expand and contract depending on the operational situation necessitating the implementation of ICM strategies.

It is important that any concepts and guidelines for delineating a corridor be compatible and consistent with the definitions of "corridor" and "integrated corridor management" as discussed in Tech Memo 3.1 and noted below:

- **Corridor** – A largely linear geographic band defined by existing and forecasted travel patterns involving both people and goods. The corridor serves a particular travel market or markets that are affected by similar transportation needs and mobility issues. The corridor includes various networks (e.g., limited access facility, surface arterial(s), transit, bicycle, pedestrian pathway, waterway) that provide similar or complementary transportation functions. Additionally, the corridor includes cross-network connections that permit the individual networks to be readily accessible from each other. The term "network" is used to denote a specific combination of facility and mode.
- **Integrated Corridor Management** – ICM consists of the operational coordination of multiple transportation networks and cross-network connections comprising a corridor and the coordination of institutions responsible for corridor mobility. The goal of ICM is to improve mobility, safety, and other transportation objectives for travelers and goods. ICM may encompass several activities, for example:
    - Cooperative and integrated policy among stakeholders responsible for operations in the corridor.
    - Concept of operations for corridor management.
    - Improving the efficiency of cross-network junctions and interfaces.
    - Mobility opportunities, including shifts to alternate routes and modes.

- Real-time traffic and transit monitoring.
- Real-time information distribution (including alternate networks).
- Congestion management (recurring and non-recurring).
- Incident management.
- Travel demand management.
- Public awareness programs.
- Transportation pricing and payment.

CONSIDERATIONS AND GUIDELINES

A key attribute of a corridor is that it has no predefined size or scale. Corridors are defined, and their boundaries established, based primarily on operational considerations: the travel market or markets served by the corridor, the similar transportation needs and mobility issues associated with these markets, the ICM activities envisioned for the corridor, and the accessibility and interaction between the networks via their cross-network connections. In other words, the boundaries of an Integrated Corridor Management System (ICMS) depend on the operational goals and objectives for ICM as determined by the stakeholders, and the corresponding needs and abilities of the various corridor networks and their respective cross-network connections, to function as an integrated system. These operational considerations and their potential impact on corridor boundaries, along with a few physical characteristics that the corridor must posses, are discussed below.

Physical Considerations

While operational considerations are paramount when establishing the boundaries of a corridor, there are a few essential physical attributes that must be addressed. These physical characteristics are included in the corridor definition, as follows:

- "Various networks" – At a very minimum, the corridor boundaries must encompass multiple networks. This involves some combination of freeways, arterials (with or without managed lanes), transit utilizing roadway right-of-way (e.g. bus, light rail), and/or transit in separate or exclusive ROW (e.g. subway, elevated rail).[1]
- "Cross-network connections that permit the individual networks to be readily accessible from each other" – Corridor boundaries need to be delineated such that cross-network optimization is feasible; that is, appropriate linkages and junctions must exist between the networks throughout the length of the corridor, thereby permitting route and mode shifts without severe mileage or travel time penalty to the travelers. This also implies that the various networks themselves are in relatively close proximity to one another.
- "Largely linear geographic band" – This, coupled with the need for **cross–network connections** along the corridor to support route and/or mode shifts, implies a corridor geometry in which the length of the corridor is much greater than its width (i.e., as measured by the distances between the adjacent networks). Otherwise, cross-network operation and management is probably not feasible.

[1] Specific network combinations with respect to corridor types are addressed in Tech Memo 5.1 – "Definition of Corridor Types."

Operational Considerations

The definition specifically states that a corridor is "defined by logical, existing and forecasted travel patterns." The definition also indicates that the "corridor serves a particular travel market or markets that are affected by similar transportation needs and mobility issues." The following boundary delineation considerations may be derived from these requirements:

- The corridor boundaries should define a pathway (largely linear) for the movement of people and goods, and this pathway should connect major sources of trips (e.g., population and employment centers, commercial establishments, intermodal facilities, special event venues). Most of the trips need to be network benign, meaning that the trips can be serviced in a similar manner by the different alternative travel choices; i.e., networks. In this way, the potential benefits of ICM are enhanced because of the ability of travelers to shift between alternatives in response to changing corridor conditions, facilitating management of the combined capacity of all the networks, or the "total capacity," of the corridor.
- There really can be no stipulation of a "maximum corridor length." A corridor's length is determined by the major origins and destinations served by the corridor. It doesn't matter how far apart these trip sources are, provided that they result in a travel market(s) with similar transportation needs and mobility issues. Note, however, that there is a practical minimum length for a corridor. This is necessitated by the defined requirement for multiple networks that are readily accessible via cross-network connections coupled with the reality that most network infrastructure has been constructed with lateral spacing between the different facilities (networks built in the same right-of-way with vertical separation being the occasional exception) and with cross-network connections and the associated junctions (e.g., freeway ramps, rail stations) spaced (longitudinally) at a nominal minimum of 1 mile. Depending on these longitudinal and lateral spacings, there is a minimum corridor length below which cross-network operations are simply not feasible in terms of travelers experiencing significant mileage and/or travel time penalties, regardless of the operational scenario. As part of an FHWA program in the mid-1970s to develop and implement the Integrated Motorist Information System (IMIS) corridor (now called INFORM), a generalized methodology[2] was developed to guide other corridor deployments. That methodology cited a minimum corridor length "of at least 5 miles (8km)…to economically justify a system" – probably a reasonable rule of thumb.

The definition of Integrated Corridor Management identifies several potential activities associated with ICM, and several of these can influence a corridor's boundaries. For example:

- **"Mobility opportunities including shifts to alternate routes and modes"** – This activity has been included as one of the overall ICM approaches[3]; specifically, "Accommodate/Promote Cross-Network Route and Modal Shifts." Such strategies assume that available spare capacity exists on the adjacent

[2] P. Zove, C. Berger, "Integrated Motorist Information System (IMIS) Feasibility and Design Study, Phase II: Generalized Methodology for IMIS Feasibility Studies," *Volume I – IMIS Feasibility Study Handbook*, FHWA-RD-78-23, May 1978.
[3] Tech Memo 5.1-3 – Corridor Types/Operational Approaches and Strategies.

networks and network linkages or junctions within the corridor. If not, consideration can be given to expanding the corridor boundaries to include additional networks that have spare capacity. Such an increase in corridor width will likely increase the mileage or travel time penalties associated with route and mode shifts, but this increase may still be less than the delays associated with a narrower, capacity-constrained corridor. (Note: An alternative and complementary approach is to implement strategies to reduce demand or provide additional capacity on a temporary basis (thereby creating spare capacity), as represented by another ICM operational approach: "Manage Capacity-Demand Relationship Within the Corridor.")

- **Congestion management (non-recurring / incident management)** – Technical Memo 3.1 ("Develop Alternative Definitions") defines[4] non-recurring congestion as "unexpected or unusual congestion caused by an event that was unexpected and transient relative to other similar days." Non-recurring congestion can be caused by a variety of factors, including, but not limited to lane blocking accidents and disabled vehicles, transit outages, construction activities, inclement weather, and significant increases in volume in comparison to "normal" volumes (e.g., a special event). Such incidents and events occur on a regular basis within most corridors, and ICM strategies (including accommodating or promoting cross-network route or mode shifts as discussed above) can be implemented to mitigate the impact on corridor users. Moreover, the corridor boundaries should be delineated with such "typical" (i.e., day-to-day) incidents and events in mind. But what of extraordinary and infrequent circumstances, such as a major incident or construction activity that completely closes a network for several hours or longer, a special event that significantly increases demand, or a disaster requiring evacuations? Another set of "outer" corridor boundaries may need to be identified for these atypical incidents and events, taking into consideration the significant decrease in network capacity or or increase in demand within the corridor boundaries, as well as the various delineation concepts already discussed. It may be that, depending on the configuration and layout of the transportation network, these outer corridor boundaries may overlap or encompass other corridors, in which case the management of such major events becomes more regional in nature.
- **Real-time traffic and transit monitoring / real-time information distribution** – A basic assumption of the ICM Initiative is that the individual networks within the corridor are approaching optimization in terms of their respective operations, including the presence of ITS technologies and management strategies. In reality, such an assumption may not always be valid. There may be limited or inadequate surveillance capabilities on some of the networks, few means for disseminating information (e.g., DMS, web sites), or some combination. If so, this should not necessarily impact the corridor boundaries per se, although it may affect the implementation scope and priorities for deploying an ICM System (e.g., focusing on corridors where the individual networks are already optimized.)
- **Cooperative and integrated policy among stakeholders** – this activity, along with **concept of operations for corridor management and communications among network operators and stakeholders,** is part of the institutional

[4] Adopted from a recent study by Washington State Dot and Washington State Transportation Center

integration so critical to the success of ICM. In essence, institutional integration involves coordination and collaboration between various agencies and jurisdictions (network owners) in such a way that transcends institutional boundaries and focuses on a larger, corridor-wide perspective. The possibility always exists that one or a few of the corridor stakeholders may not agree on the roles, responsibilities, and shared operational strategies associated with ICM. Should such an unfortunate scenario arise, it may be necessary to modify the ICM approaches and strategies and adjust the corridor boundaries such that these reluctant stakeholders are more on the periphery of the corridor and its management.

PROCESS

The various concepts and guidelines for identifying corridors and delineating their boundaries, as discussed above and summarized in Table 1, need to be considered (and reconsidered) throughout the life cycle of an Integrated Corridor Management System. This iterative process and the associated activities are discussed in the *ICM Implementation Guidance* (and summarized in Table 2).

Table 1 – Summary of Corridor Boundary Delineation Concepts and Guidelines

- A key attribute of a corridor is that it has no predefined size or scale.
- Encompass multiple networks. This involves some combination of freeways, arterials (with or without managed lanes), transit utilizing roadway right-of-way (e.g. bus/light rail), or transit in separate or exclusive ROW (e.g. subway, elevated rail).
- The individual networks within the corridor are approaching optimization in terms of their respective operations, including the presence of ITS technologies and management strategies.
- Appropriate cross-network linkages and junctions exist throughout the length of the corridor thereby permitting route and mode shifts without severe mileage and/or travel time penalty to the travelers.
- Forms a largely linear geographic band (i.e., the length of the corridor is much greater than its width).
- Define a pathway for the movement of people and goods, with this pathway connecting major sources of trips (e.g., population and employment centers, commercial establishments, intermodal facilities, special event venues). These trips need to be network benign meaning that the trip can be serviced in a similar manner by the different alternative travel choices facilitating total corridor capacity and demand management.
- No “maximum corridor length.” A corridor’s length is determined by the major origins and destinations served by the corridor. The distance between these trip sources is irrelevant provided that they result in a travel market(s) with similar transportation needs and mobility issues.
- A practical minimum length for a corridor exists (5 miles as a rule-of-thumb).

Table 1 – Summary of Corridor Boundary Delineation Concepts and Guidelines (continued)

- Provides mobility opportunities including shifts to alternate routes and modes. This assumes that available spare capacity exists on the adjacent networks and network linkages or junctions within the corridor under some operational scenarios.
- Outer (extended) boundaries should be considered for extraordinary (atypical and infrequent) circumstances, such as a major incident or construction activity that completely closes a network for several hours or longer, a special event that significantly increases demand, or a disaster requiring evacuations.
- Always keep in mind that the overall goal of ICM is for the corridor to operate as an integrated system such that all the existing capacity can be more effectively used.

Table 2 – ICMS Implementation Guidance Outline

- Concept Generation
- Systems Engineering Management Plan
- System Conception
- Requirements
- ICMS High Level Design (Architecture)
- ICM Detailed Design
- Procurement
- Implementation & Deployment
- Operations and Maintenance / Evaluation
- Configuration Management (Crosscutting Process)

There are three major "levels" for this corridor delineation analysis as discussed below:

- **Concept Generation** – The activities during this initial step include establishing the stakeholder group and making a preliminary identification of the corridors and their respective boundaries. This "first level" delineation is primarily conceptual and qualitative in nature, relying on local knowledge and possibly a high-level review of any available data on travel patterns and markets, combined with engineering judgment (considering the various guidelines previously discussed) to develop a "first draft" of corridor boundaries. The intent of this initial activity is to ferret out the rough impact area of the corridor (e.g., drawing elongated ovals or rectangles on a map of the metropolitan area or region), identifying the corridor networks, cross-network linkages and junctions, the major trip ends and the primary and alternate routes and modes that serve them.

- **System Conception** – This next step of the process results in a Concept of Operations for the proposed ICMS. The various activities associated with developing the ICMS Con Ops — such as inventory of existing systems and network characteristics, identification of current operational conditions and deficiencies, needs analysis, corridor vision and goals, potential ICM approaches and strategies, institutional framework, etc. — provide information that is also used to further refine the corridor boundaries. Examples of this quantitative analysis include:
    - Identify operational characteristics within the corridor (e.g., frequency of incidents / events and their general location and impact, potential weather impacts, whether the corridor is part of an evacuation route, time-of-day / day-of-week / time-of-year considerations) and define potential ICM scenarios and strategies.
    - Identify individual major trip ends and their specific alternative routes and modes (including the associated cross network linkages and junctions) for the operational scenarios.
    - Determine the spare capacity of the individual networks and cross-network linkages or junctions (vis-à-vis trip volumes, transit loadings, parking demand) and the total spare capacity within the corridor for the various ICM scenarios.
    - Estimate the additional travel time for likely network shifts
    - Based on these operational analyses, which can likely be done via simple calculations in a spreadsheet format, the corridor boundaries may be further refined and adjusted; for example, expanding the corridor boundaries for selected operational scenarios to increase the amount of spare capacity, reducing the corridor width due to excessive travel time penalties, identifying scenarios which may require a regional (corridor-to-corridor shifts) approach.

  The refined corridor boundaries, and the operational scenarios for which they are valid, should be included in the ICMS Concept of Operations Document.

- **Detailed Analysis** – This optional activity would entail simulating the corridor and any alternative boundaries under a variety of operational scenarios and combinations of ICM approaches and strategies. Simulation techniques that vary demand and capacity and that provide for network shifts should be used. This analysis would permit a detailed evaluation of corridor and individual network performance when operated as an ICMS under a variety of different boundaries and scenarios (i.e., demand situations). A trade-off will probably need to be made between the characteristics of the corridor to support the chosen strategies; the different scenarios (e.g., recurring, incident, special event, evacuation) that need to be addressed; the ability to manage spare capacity or to create spare capacity; and the boundaries that identify the operational impact of the corridor. The analysis may suggest that there is a regular operations boundary and an extreme operations boundary for scenarios such as evacuations. The differences in boundaries will indicate strategy operations areas, institutional dynamics, and different levels of operational responsibilities. This detailed analysis can be performed at the end of System Conception or during Requirements.

Finally, it is emphasized that a corridor's boundaries are never truly final. During the "Evaluation, Operation, and Maintenance" phase of the ICMS life-cycle, the operation of the corridor as a whole is evaluated using ICM performance measures, and adjustments to the ICMS are made as appropriate. Such refinements may be operational, technical, or institutional in nature, and they may include changes to the corridor boundaries as well, which may require additional conceptual and detailed analyses.