The Industry Cluster as a Planning Construct for Freight ITS

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ABSTRACT
The integration of public and private stakeholders and information flows is a challenge for planners developing regional and local ITS concepts and architectures involving freight movement. The economic development literature has established the “Industry Cluster” as a planning construct based on time, space and linkages among firms in different industries. This conceptual paper looks beyond the geographically constrained view of the industry cluster to assess the promise of the “value-chain” industry cluster as a construct for planning ITS architectures and operational concepts. The paper (1) identifies and defines the value chain industry cluster as an appropriate construct for ITS planning (2) suggests a four-step industry cluster based approach to developing integrated public and private ITS concepts of operations and architectures within the USDOT guidance for Regional ITS Architecture and (3) offers examples of practical freight ITS issues which can effectively be addressed at the industry cluster level.
INTRODUCTION

As regional ITS architectures become more widespread and sophisticated, commercial ITS systems are becoming increasingly relevant in the concepts of operations for both public and private sector transportation and infrastructure providers. Identifying, defining and implementing the incentives and roles of industrial and business partners in ITS architectures is a critical component of effective freight ITS planning; however very few cases of truly integrated public and private systems have succeeded. The collaboration between private firms in different industries surrounding transportation technologies, and between private firms and public entities requires a conceptual framework rooted in both the fields of transportation planning and economic development, as well as supply chain management. The concept of the “industry cluster” has been widely researched and implemented in the economic development literature; but has yet to find widespread application in transportation planning. This paper identifies and defines the value chain industry cluster as an appropriate construct for ITS planning suggests a four-step industry cluster based approach to developing integrated public and private ITS concepts of operations and architectures within the USDOT guidance for Regional ITS Architecture and offers examples of practical freight ITS issues which can effectively be addressed at the industry cluster level.

LITERATURE REVIEW

In the field of economic development, several researchers have examined the concept of the industry cluster as a valid construct and tool of analysis in economic development at all policy levels. Porter’s work continues to be the benchmark by which most current state and local cluster initiatives are measured. Others have taken the concept in different, arguably more robust and less geographically constrained directions. Roelandt and den Hertog identified the ‘value-chain’ industry cluster as “a cluster consisting of an extended input-output or buyer-supplier chain comprised of multiple sectors or industries and including final market producers as well as suppliers at all tiers directly or indirectly involved in trade.” This definition of an industry cluster is consistent with the industry cluster described two decades earlier by Czamanski and de Ablas. In response to an abundance of literature detailing the geographic proximity and various agglomeration-related spillovers of industrial clusters, Bergman and Feser show that increasingly industry clusters are not constrained by the spatial proximity of member actors and may in fact be less prone to distance-sensitive constraints on realized mutual benefit and synergistic competitiveness. The ‘binding ties’ between cluster members may in fact consist of linkages between geographically dispersed members of the same value-chain industry cluster. Further, Feser and Sweeney determined that geographic agglomeration is really only crucial for knowledge-based or technology-sensitive clusters.

Significant work has also been completed on the role of information technology and sophisticated logistics management systems in industrial value chain relationships. McCann and Fingleton discussed the spatial impact of Just-In-Time (JIT) buyer-supplier relationships on Japanese JIT manufacturing entities in the Scottish electronics industry. Tsao and Botha developed system operating concepts and deployment sequences for the automation of inner-city trucking with the expressed intent of, among other things, increasing vehicle throughput and satisfying the numerous stakeholders involved. Mahajan and Vakharia point out the importance of IT alliances between
Research in the areas of transportation and intelligent transportation systems (ITS) has also focused on the use of technology and value-chain management systems to facilitate inter-firm transaction processing and streamline point-of-sale logistical protocol. Yoshimura, Kjeldgaard, Turnquist, and List (9) made the case for an expanded and more versatile transportation modeling system that would support both logistics and operations processes and integrate improved transportation decision tools in the areas of package allocation, fleet sizing, and routing/scheduling. Jensen, Williamson, Sanchez, and Mitchell (10) completed an evaluation of an ITS-enabled intermodal supply chain manifest system designed to increase air cargo security and streamline the logistics systems deployed at O'Hare and JFK international airports. The authors found that the technology did in fact create a secure electronic intermodal manifest system that both saved time and satisfied end users. Satisfied participants also recommended that the system would be even more useful if adopted by additional supply chain partners. Eisele and Rilett (11) exposed the lingering need for accurate estimations of travel time data to buttress both real-time and off-line transportation management applications—including those intended for use by freight haulers. Cambridge Systematics (12) detailed the four main categories of fleet management technology: automatic vehicle location (AVL) systems, mobile communications systems, on-board computers (OBCs) and routing/dispatching software. Opdam (13) completed a study of the efforts--and mixed results--of a U.S. cement company employing an advanced routing system to locate the closest truck to a delivery point and successfully navigate stagnant beltway traffic. Srour, Kennedy, Jensen, and Mitchell (14) completed a thorough evaluation of a major real-time freight information system designed by the New York Port Authority to merge the numerous sources of freight location and status information into one, easily navigable web portal utilized by end users to access cargo information and facilitate both transportation planning and logistics. Rao, Navoth, and Horwitch (15) examined the rise of third-party logistics and distribution providers, highlighting FedEx’s efforts to capitalize on the urgent need to merge ‘virtual-world’ information technology and the ‘real-world’ physical delivery of products. Button, Doyle, and Stough (16) found that by implementing sophisticated dispatching software, a courier company increased driver productivity 24% and unexpectedly decreased the amount of stress born by the company’s dispatchers.

Relatively little research has been completed to date on the convergence between economic development’s industry cluster literature and transportation’s use of information technology to enhance value-chain transactions. Several (e.g. Von Thunen (17), Weber (18), Greenhut (19), Richards (20), Ziegler (21), Kilkenny (22)) have examined the role of transportation as a factor cost in industrial location decisions. Bergman (23) examines the technology adoption rate of members of the transportation equipment value chain and supports policies that work through the market structure of regional economies and a firm’s own value-chain to promote technology adoption. Munnich and Lehnoff (24) explored the effect of ITS on the spatially agglomerated recreational transportation cluster in rural northwestern Minnesota, finding that ITS investments occurred disproportionately in the cluster’s larger firms. However, none of these studies have explicitly defined the value chain industry cluster as an ITS planning
construct, or set forth practical applications of cluster analyses in the development of ITS architectures and concepts of operations.

**DEFINING THE INDUSTRY CLUSTER IN SUPPLY CHAIN TERMS**

The term “industry cluster” has been used loosely by economic development and transportation practitioners to describe groups of businesses or establishments in different contexts. The concept of the industry cluster has often been misunderstood in the transportation planning community for two reasons. First, methods for integrating formal methods of economic industry cluster analysis into transportation planning have not been widely implemented, and second, a straightforward process of using the cluster concept in transportation planning has never before been introduced.

Consequently, transportation planning efforts attempting to utilize the “cluster” concept have often resorted to very simplistic studies that fail to grasp the transportation planning significance of true industry cluster relationships as defined in the literature above. For example, a recent freight study in Minnesota (25) used aerial photography to identify groups of non-residential buildings in close proximity and defined each group as a “cluster” without identifying the occupancy status, industry, type of business, or transportation and trading linkages between such businesses.

For this reason, effectively implementing the cluster concept in freight ITS planning requires (1) a working set of definitions for industry clusters of different types (2) an understanding of the theoretical basis of the cluster concept in economic terms and (3) an understanding of how collaborative, technology-based transportation and distribution relationships between firms in different industries can serve to catalyze industry clusters likely to have a stake in ITS planning and implementation.

**Industry Cluster Definitions**

In concept, industry clusters are defined in the literature cited above as groups of firms from multiple industries that are motivated by competitive pressures to form collaborative or competitive relationships. The dynamic of an industry cluster is determined by

1. **Time.** The cluster dynamic is affected by the period over which relationships among firms and industries evolves, as well as a function of the distance between their physical locations.

2. **Space.** The cluster dynamic is affected by the spatial proximity of firms to one another, and the degree to which space strengthens or hinders their relationships.

3. **Linkage.** The cluster is affected by the type of linkage between the firms, whether the firms are competitors, likely to be collaborators, or simply share the same resource pool.

   Bergman and Feser (4) provide a comprehensive set of definitions for industry clusters and related concepts shown in Table 1.

**Theoretical Basis of the Cluster Concept**
Diamond of Advantage

Michael Porter’s “Diamond of Advantage” (1) provides the theoretical basis for understanding intra-industry and inter-industry relationships in the industry cluster framework. While Porter’s work viewed advantages as primarily national in nature, as opposed to regional within a domestic economy, certain key principles from Porter’s “diamond” are useful for understanding industry clusters as relate to ITS and transportation related technologies.

The Porter “Diamond of Advantage” characterizes economic vitality of as a function of four conditions that drive innovation and productivity improvement:

1. **Factor Conditions:** Conditions that make available resources, technologies and opportunities unique to a select group of firms (such as culturally embedded tacit knowledge in the workforce, natural geographic resources such as proximity to an ocean or river).

2. **Demand Conditions:** The degree to which the environment provides viable markets for products and services.

3. **Related and Supporting Firms:** The degree to which the environment offers opportunities for mutualistic collaboration and cooperation among partners in different industries with complementary interests, needs or problems.

4. **Firm Structure, Strategy and Rivalry:** The degree and manner in which firms are able enact strategies to compete with each other within and among industries.

Government and chance factors are understood as external to Porter’s “Diamond” but affect economic vitality indirectly through influences on each of the four “corners” of the diamond. Munnich (24) (2003), interpreted Porter’s “Diamond of Advantage” in terms of potential ITS applications as shown in Figure 1.

The broad categories of the activities in the boxes of Figure 1 represent opportunities for collaboration among industries that have the potential to support economic vitality by enabling firms to use the transportation system in a more efficient and innovative manner.

**Beyond the “Diamond”**

As can be inferred by Figure I, it is difficult to translate the general four points of Porter’s “Diamond of Advantage” into specific types of relationships among firms using specific types of technologies and strategies. The “Diamond” framework addresses collaborative relationships among firms under the general category of “related and supporting firms” and classifies technology as a “factor condition,” but does not specify the competitive pressures by which firms are motivated to enter into specific types of relationships. Furthermore, because government is exogenous to the “Diamond” the roles and relationships of public and private actors required for integrated ITS planning at the industry cluster level are ambiguous at best.
Ultimately, though Porter recognizes that clusters are not always spatially agglomerated, the “Diamond” has been widely interpreted by planners as a construct used to understand only spatially agglomerated industry clusters. This bias towards the industry cluster as a strictly local (or regional) concept poses limitations in its application to relationships among firms exchanging commodities across long distances through freight transportation activities. The strictly local (or regional) interpretation of the cluster concept has worked to the detriment of transportation planners seeking to develop ITS operational concepts and architectures. The strictly localized interpretation of the industry cluster is not appropriate for the global economy, in which decisions and partners far away, in other parts of the world can be more important to a business than partners in the local area. Consequently, ITS freight planning requires a more global view of industry clusters than has typically been applied. A cluster-based approach to ITS freight planning must recognize that the most critical economic relationships among firms in a transportation system are likely to be national and global in nature; with a common interest in transportation activities often serving as the catalyst for collaboration. Carrying the argument further requires examining the relationships underlying the “Diamond of Advantage” at the more refined level.

To get beyond the limitations of the “Diamond” it is useful to consult Porter’s “Five Forces” model. The “Five Forces” model of industry competitiveness provides a more specific way of identifying and classifying the relationships implicit in the “Diamond of Advantage” in which transportation technologies can be found to play a role.

In the Five Forces model, Porter argues that the intensity of competition within an industry is driven by:

1. Strategic Rivalry Among Firms
2. Pressures from Buyers
3. Pressures from Suppliers
4. The Threat of New Entrants
5. The Threat of Substitute Products

The critical elements of competitiveness common to the “Five Forces” and the “Diamond of Advantage” are the pressures businesses face from buyers and suppliers; and the need for firms to innovate to competitively position themselves within the marketplace in response to these and other pressures.

In this context, the relationships between a firm in any given industry and firms in buying and supplying industries provide a key lever for competitiveness, and create a strong incentive for buying and supplying firms to collaborate. In manufacturing industries, this collaboration almost by definition must include collaboration on the physical movement of raw materials and products, as quantities, prices, schedules and other logistical factors are key determinants of costs and operational strategies on both sides of the buyer and supplier relationship. With reference to transportation, government finds its place in the “Five Forces” framework as a supplier of infrastructure.

Understanding exactly (1) how transportation and distribution related technologies engender such collaboration, (2) how the relationships implicit in such collaboration can be properly defined and understood in terms of industry clusters, and (3) how these relationships fit into an ITS architecture or concept of operations is
important for ascertaining the significance of the industry cluster as a construct for ITS planning and policy.

**Collaborative Supply Chains as Industry Cluster Catalysts**

The evolution of advanced supply chain management technologies has resulted in collaborative groups of firms in different industries using information technology to more efficiently manage the distribution and transportation of inputs and commodities. Through these collaborative, technology-based relationships, firms in different industries and different locations function as industry clusters under the Bergman and Feser (4) definitions.

By the nature of their collaboration up and down the supply chain, clusters bound together by collaborative supply chain management strategies represent partnerships among firms, flows of information and a shared interest in the distribution and transportation activities that makes them important stakeholders in and potential contributors to freight ITS systems.

Six examples of collaborative, technology-driven strategies that form industries into clusters are presented below with a brief discussion of how the relationships function as clusters and the relevance of such clusters to ITS planning.

**Six Strategies**

**Electronic Data Interchange (EDI)** is the computer-to-computer transmission of business information between trading partners. The type of data included in an EDI system consists of purchase orders, invoices, shipping notices and funds transfer. As with many of these strategies, the freight carrier is a key transportation intermediary of EDI when it involves shipping notices. EDI networks are very sensitive to information security because strategically sensitive information about productive capabilities, markets, operational methods and distribution channels are included in the data exchanged. EDI systems are generally employed by large, corporate firms with national distribution systems.

**EDI Users as Industry Clusters.** The participants in EDI systems can always be described as industry clusters, because membership in the system is an important element of each firm’s individual competitiveness, and “buyer supplier” relationships and distribution channels always bind together members of EDI systems. The relationships among EDI partners further meet the definition of industry clusters because by definition EDI partners must share the common information technology of the EDI.

The potential of EDI in complex, multi-tiered supply chains to foster “value chain” industry cluster relationships is limited only by the level of trust among EDI partners, the intermediaries available to facilitate and manage the potentially complicated information networks needed to support such systems, and the “critical mass” of firms across industries that may find a mutual interest in engaging in and EDI system.

**EDI Clusters and ITS.** Industry clusters comprised of EDI participants change the utilization of the transportation system, and create the possible roles and contributions to commercial vehicle ITS by:
Affecting and tracking the scheduling of truck runs

Affecting the and tracking the amount and types of commodities shipped in each load; and

Automating orders and shipments between shippers and carriers

**Cross Docking** is a system in which merchandise received at the warehouse or distribution center is not put away, but instead readied for shipment to retail stores. A key requirement of cross docking is the close synchronization of all inbound and outbound shipments. Cross docking changes the function of the distribution center, transforming it from a warehouse to a node of information management and continuous trucking activity. The prospects of multi-modal and inter-modal cross docking facilities have been explored in many states, ranging from the New York/New Jersey “Freight Village” to the North Carolina “Global Transpark.” However, the overall effectiveness of public cross-docking facilities as an investment in economic development has not clearly been determined by cost-benefit studies. Currently, the most immediate implications of cross-docking appear to be in the significantly more intensive level of carrier activity at cross docking distribution sites that are mode-specific to trucks; as well as the informational requirements placed on carriers.

**Cross Docking Firms as Industry Clusters.** Participants in a Cross-docking system clearly meet the definition of industry clusters, because membership in the cross-docking arrangement is an important element of each member firm’s competitiveness, and “buyer-supplier” relationships are central to binding firms together in a cross docking scheme. More sophisticated cross-docking schemes and concepts like those mentioned above, function as both “value chain” industry clusters and national industry clusters, as they combine spatial agglomeration with value-chain linkage.

**Cross Docking Clusters and ITS.** The critical component of a cross-docking arrangement is the close synchronization of inbound and out-bound shipments. This requires carriers to have current information about the status of activities occurring at the cross docking facility to manage dispatch, routing and scheduling. Without the appropriate information systems in place, carriers could not integrate their operations with the complex operational activities associated with cross docking facilities, hence cross docking is a highly ITS-oriented strategy. Cross docking transforms a manufacturing site into a critical node of both transportation activity and information management. The information flows associated with cross docking are potentially both a requirement and a resource for freight ITS systems.

**Efficient Consumer Response (ECR)** is a strategy in which the retailer, distributor, and supplier trading partners, and intermediaries, study methods to work closely together to eliminate excess costs from the supply chain and better serve the customer. ECR is by definition focused largely on business-to-consumer supply chain relationships.

**ECR Participants as Industry Clusters.** Businesses collaborating in ECR schemes are not, by definition industry clusters. While they are bound together by buyer-supplier
relationships and distribution channels, the ECR may or may not be an important element of each firm’s competitiveness. For example, a group of firms may simply study methods of working together to eliminate excess costs and better serve customers, but the collaboration may not result in any actionable system being implemented. ECR arrangements can best be classified as potential industry clusters, in which some become industry clusters when they begin depending upon a specific technology (such as VMI, EDI, QR or another of the strategies discussed in this section) to reap the benefits of collaboration.

**ECR Potential Clusters and ITS.** ECR does not directly depend on ITS, but rather seeks ways to use other collaborative technologies. If carriers participate in a group of firms participating in ECR, they may introduce cost-saving measures for the transportation element of the supply chain, but ECR does not depend on this. Overall ECR assumes that carriers and infrastructure providers can be responsive to whatever customer response strategies arise from collaboration among retailers and other supply chain partners. Consequently it is likely that ECR will place additional requirements on carriers, hence understanding these requirements, and taking them into account in ITS planning can potentially enhance the cohesion and effectiveness of a comprehensive ITS strategy.

**Quick Response** is a partnership strategy in which suppliers and retailers work together to respond more rapidly to the consumer by sharing point-of-sale data, enabling both to forecast replenishment needs. EDI and bar coding are used to speed the flow of information and product. Quick Response is very similar to ECR in the policy and planning questions it raises. Even more than EDI, it raises issues of how and when truckloads arrive at the point of sale.

**QR Participants as Industry Clusters.** Firms collaborating in QR arrangements are by definition industry clusters, because at the heart of their collaboration is improved competitiveness for each of the firms involved in the partnership, and the partners are bound together by buyer-supplier relationships (in this case originating at the point of sale). QR clusters can also be safely classified as “value chain clusters” because they always include final market producers and multiple tiers of suppliers across multiple industries.

**QR Clusters and ITS.** Because QR requires the carrier to deliver much smaller and more specific quantities to the point of sale on much shorter notice; to say the least ITS on the carrier end is likely to enhance the effectiveness of QR. The most efficient QR system would intuitively be one in which the carrier is a member of the QR cluster itself, in which point of sale data becomes available to the carrier, enabling the carrier to plan and schedule the transportation operations using the same point of sale information on which other upstream suppliers are utilizing in a QR arrangement.

Beyond collaboration with the carriers, the potential benefits of private QR business groups sharing point of sale data and data regarding QR shipments with public entities implementing freight ITS such as ports and inter-modal freight facilities could potentially enable transportation planners and managers to use information technology to better
manage freight operations, and the opportunity to better plan the capacity of such facilities.

**Continuous Replenishment Process** (CRP) is the practice of partnering among distribution channel members that changes the traditional replenishment process from distributor generated purchase orders to one based on actual or forecasted consumer demand.

*CRP as Industry Clusters.* Firms collaborating in CRP arrangements have very similar relationships to those in QR arrangements, in that they the key shared element among firms is point of sale data, which then drives other operations. Hence for the same reasons as QR arrangements, firms collaborating in CRP can safely be classified as industry clusters.

*CRP Clusters and ITS.* As with QR, the key information and technology requirement associated with CRP is the transfer of point of sale data. This does not depend on ITS, hence CRP cannot be classified as an ITS-enabled strategy in and of itself. ITS becomes relevant to CRP in the degree to which carriers, 3PLs and other intermediaries depend on ITS to respond to the demands of shippers engaging in CRP clusters. The main ITS issues associated with CRP lie in the potential for public sector infrastructure providers to themselves become members of a CRP cluster. The forecasting capabilities of CRP systems could potentially be useful from the standpoint of ATIS and traffic operations management, if key infrastructure providers are built into the information infrastructure of CRP networks. For example, if there is an incident of inclement weather, rendering certain bridges or roadway network links impassible or unsafe; then a traffic management operation could respond to a CRP forecast levels of truck traffic on that day to assist carriers in finding alternate routes, with detailed information about the routes and volumes likely to occur on that particular day.

**Third Party Outsourcing** is the practice of delegating responsibilities to specialized outside firms with the objective of improving service, through specialization, and reducing assets deployed by the firm. Examples include using third party logistics firms (3PLs) to assume the transportation function including managing private fleets.

*3PL Arrangements as Industry Clusters and as Pertain to ITS*  
While 3PL clients are clearly not industry clusters because they all coordinate through the 3PL as an intermediary (as opposed to collaborating with each other), they are critically important to many of the other strategies described in this section. Furthermore, because 3PLs serve as a central node of information between shippers and carriers, they are potentially very important players in the future of ITS operational concepts and architectures.

These are only six examples of the types of strategies that form supply chains into industry clusters. The examples illustrate ways in which it is not individual firms, or singular industries; but interactive clusters of industries that use the freight transportation system. The examples furthermore demonstrate the ways in which clusters represent distinctive transportation and technology requirements, decision-making processes and
information flows with the potential to both contribute to and benefit from inclusion in regional ITS architectures and operational concepts.

**A 4-STEP PROCESS FOR INTEGRATING INDUSTRY CLUSTERS INTO ITS PLANNING**

To incorporate industry clusters into the ITS planning process, four steps are recommended, in conjunction with the four steps of developing regional ITS architecture set forth in the USDOT Regional ITS Architecture Guidance Document (27) (Figure 2):

1. Identify Relevant Industry Clusters and Strategies
2. Ascertain the Unique Transportation Requirements of Each Cluster
3. Define the Roles of Transportation Technologies in Meeting Those Requirements
4. Establish formal and informal Hierarchies of Transportation Decision Making with appropriate information systems and standards.

The process can be applied for any entity for which a regional ITS architecture or concept of operations is required. Some examples may include trade or technology corridors, freight villages, inter-modal freight facilities and ports.

**1. Identify Relevant Industry Clusters and Strategies**

The process of identifying relevant industry clusters and strategies for incorporation into an ITS architecture or concept of operations begins with identifying basic shipping industries using the infrastructure.

1. Identify Major Basic Industries in the Area Served by the Infrastructure using location quotients (ratio of regional industry share to national industry share).

2. Construct Supply Chains for Basic Industries using input-output multipliers to identify secondary and tertiary buyers and suppliers, including public infrastructure providers, emergency response organizations, enforcement agencies and other public entities as suppliers of transportation related services.

3. Identify Collaborative Supply Chain and Distribution strategies and technologies active within key supply chains by involving industry stakeholders.

4. Identify Information Flows Associated with these strategies and technologies

**2. Ascertain the Unique Transportation Requirements of Each Cluster**

By examining each cluster as a whole, critical decision points, transportation bottlenecks, chokepoints and critical paths can be identified (including not only capacity constraints, but time-lags for shippers, sources of delay for carriers and sources of inefficiency for both shippers and carriers).

**3. Define the Roles of Transportation Technologies in Meeting Those Requirements**
Based on the information flows between cluster members, and the potential public sector ITS systems, identify ways to supplement public and private information flows between cluster members to provide optimal information at key decision points, and minimize inefficiencies caused by lag times, infrastructure capacity constraints, and other sources of delay.

4. Establish a Hierarchy of Decision Makers and Decision Making
To identify specific decision support requirements and priorities, establish those decisions, entities making critical decisions with impact throughout the value chain. In this process, identify specific types of information available from information flows present in the cluster that would support those decisions and establish agreements, systems and standards to provide integrated decision support through the ITS effort.

PRACTICAL APPLICATIONS AND ADVANTAGES OF THE VALUE CHAIN CLUSTER CONCEPT
Ultimately, the key to a successful integrated public-private cluster-based ITS architecture or concept of operations rests with the tangible payoffs in competitive business and policy terms for cluster members. The following are some examples of transportation related business and policy situations in which private sector information flows within value-chain industry clusters could be supplemented and synergized with cluster level ITS planning efforts through cohesive architectures and operational concepts. The examples are offered to both support the merits of ITS planning at the industry cluster level, and to suggest how such an approach can offer tangible and attractive payoffs for all cluster members (including infrastructure providers).

Architectures Addressing Diurnal Operational Rhythms and Cycles:

Freight transportation is a derived demand industry. Its time of day operating patterns are determined by the diurnal cycles of business, with morning deliveries to supply the day’s activities, and afternoon pickups to collect the day’s output. Freight carriers are concerned with the productivity of equipment and personnel, and already travel off-peak to the extent their customers’ schedules will allow. Within these time cycles, they have constructed network balance, volume economies, and staffing plans to produce responsive service at a competitive cost.

While a number of public transportation agencies have made attempts to encourage off-peak commercial delivery patterns, changing the time pattern of business interrupts these economics, and there is a critical mass of commercial volume required before a new pattern is really productive. Complicating the picture is the fact that the volume transferred to a new schedule is stripped from an old one, and both schedules may become economically infeasible during the transition.

One potential strategy for synchronizing freight delivery hours of operation is for an inter-firm organizational management structure set forth in an ITS concept of operations to facilitate uniform shifts in operating patterns across an entire supply chain using a given infrastructure network or system. ITS systems and real-time scheduling information could act as significant catalysts in altering time of day patterns to off-peak hours, especially if modeling such a shift within the ITS planning process could demonstrate significant benefits to all members of the value chain. Because any one member of the business community may feel powerless to alter the operating pattern and
believe it is simply responding to the demands of others, the structure of an ITS architecture is useful to address and help unite the whole.

Architectures Consolidating Asset Utilization Within the Cluster

Another practical situation in which ITS planning can offer benefits at the value chain industry cluster level involves optimizing the utilization of the assets of transportation related technologies and information flows. This goal has been suggested in recent discussion of an integrated approach to information systems international air cargo operations in the Twin Cities Metropolitan Area. An Air Cargo Task Force in the Mpls/St. Paul region has lead a number of studies which among other things have identified more than 50 air cargo freight forwarders.

A significant issue for the region is that international air cargo drayed to Chicago is often interred for several days while a forwarder attempts to “fill” a truck. A study of the issue has proposed the creation of a consolidation center whereby all participating air cargo forwarders would operate on a “shared” information system and drayage fleet. This would increase the efficiency of not only the information technology, but of the trucks, warehouse facilities and other key transportation resources in the value chain. By identifying the relevant value-chain clusters to be served by the facility with their relevant strategies and technologies, ascertaining their transportation requirements at the value-chain level, defining the roles and responsibilities of public and private entities and establishing key decision points and decision support requirements as described in the previous section, a cluster-based concept of operations for such a system could offer reduced costs and increased efficiencies for private sector cluster members, and an optimal use of the relevant ports and highways for public sector collaborators.

Architectures Combining Regional Proximity and Value-Chain Linkage

Increasing global trade is believed to have a positive impact on the United States’ economy and on gateway urban areas, but the increase in trade together with air express, and just-in-time business expectations is often associated with concurrent increases in truck vehicle miles traveled (VMT), air pollution, urban congestion, and reductions in quality of life and regional competitiveness. One way to reduce truck VMT and truck-based congestion in urban areas may be to maximize inter-modal transfer as close to, but not in, the urban market as possible.

The concept of the Freight Village is a scenario in which inter-modal activities are concentrated by co-located shippers at inter-modal facilities just outside of major metropolitan areas. There are currently more than 40 “freight villages” in Europe. And recently there has been interest in the freight village concept in the U.S.

A distinguishing characteristic of Freight Villages is the tendency of developments to focus on a few targeted industry sectors such as high technology, auto parts or foods. This clustering activity also extends to markets served, the type of market and the use or dependence on more than one mode of transportation. Freight Village efforts in the United States, (and global transparks, which utilize a similar concept) are still relatively new, and key success factors for US Freight Villages have yet to be identified.

However, integrated logistics, including integrated data systems among the parties located in the village appear to be a likely factor of success. Incorporating an integrated cluster-based ITS concept of operations and associated architecture in the transportation
planning for a Freight Village may increase the viability and effectiveness of the Freight Village concept, by explicitly accounting for the industry cluster linkages when recruiting firms into the Freight Village and enabling the Freight Village to offer members something more than a location with proximity to both an inter-modal facility and a major trade center.

CONCLUSION
The industry cluster is an established construct in the Economic Development literature which holds promise for transportation planners seeking to develop integrated public and private ITS systems for freight operations. Effective ITS planning and management can benefit from recognizing clusters in value-chain terms and incorporating the identification and analysis of value chain industry clusters in the scoping and implementation of ITS planning studies for technology corridors, freight villages, ports and other infrastructure systems. An industry cluster based approach to planning ITS systems consistent with national best practices in regional ITS planning is likely to result in opportunities and payoffs for the affected transportation systems and their users. Consequently when scoping ITS planning studies and architectures, including steps to include and explicitly address industry clusters in each step of the ITS planning process can be an important element when the ITS system involves freight operations.
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REFERENCES

LIST OF TABLES AND FIGURES:

FIGURE 1: Porter’s Diamond of Advantage as Pertains to ITS Opportunities (23)
FIGURE 2: US DOT Regional ITS Architecture Guidance (27)

TABLE 1: Industry Cluster Definitions of Feser and Bergman (4)
FIGURE 1

Michael Porter's *Diamond of Advantage* - Potential Applications of ITS to Industry Clusters

- Government
  - Telecommunications Strategies
  - Partnerships
- Firm Strategy and Rivalry
- Demand Conditions
- Related and Supporting Firms
  - Supply-chain management
  - Electronic Data
  - Integrated Logistics Mgmt
  - Just-in-Time Manufacturing
- Factor Conditions
- Chance
  - E-shopping
  - Inventory tracking
  - New market/ product opportunities
  - Electronic Funds Transfer
  - Electronic manifests
  - E-business
FIGURE 2

STEP #1: GET STARTED
(See Section 3)
- Identify Need
- Define Region
- Identify Stakeholders
- Identify Champions
  1. Identify Relevant Industry Clusters

STEP #2: GATHER DATA
(See Section 4)
- Inventory Systems
- Determine Needs and Services
- Develop Operational Concept
- Define Functional Requirements
  2. Ascertain the Unique Transportation Requirements of Each Cluster

STEP #3: DEFINE INTERFACES
(See Section 5)
- Identify Interconnects
- Define Information Flows
  3. Define Roles of Technologies in Meeting Cluster Needs

STEP #4: IMPLEMENTATION
(See Section 6)
- Define Project Sequencing
- Develop List of Agency Agreements
- Identify ITS Standards
  4. Establish Hierarchy of Decision Making

STEP #5: USE THE REGIONAL ARCHITECTURE
(See Section 7.1-7.2)

STEP #6: MAINTAIN THE REGIONAL ARCHITECTURE
(See Section 7.3)
TABLE 1 (Source: Regional Research Institute, with permission)

<table>
<thead>
<tr>
<th>Concept</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sector (or Industry)</td>
<td>A sector or industry is a group of enterprises that manufacture similar products, as typically defined, for example, under the U.S. Standard Industrial Classification (SIC) system.</td>
</tr>
<tr>
<td>Industry cluster</td>
<td>A group of business enterprises and non-business organizations for which membership within the group is an important element of each member firm’s individual competitiveness. Binding the cluster together are &quot;buyer-supplier relationships, or common technologies, common buyers or distribution channels, or common labor pools (Enright 1997, p. 191).” See Porter (1990).</td>
</tr>
<tr>
<td>Regional industry cluster</td>
<td>A cluster whose elements share a common regional location, where region is defined as a metropolitan area, labor market, or other functional economic unit.</td>
</tr>
<tr>
<td>Potential industry cluster</td>
<td>A group of related and supporting businesses and institutions, that, given additional core elements, interfirm relationships, or critical linking sectors, would obtain some pre-defined critical mass.</td>
</tr>
<tr>
<td>Value-chain industry cluster</td>
<td>A value chain cluster is an industry cluster identified as an extended input-output or buyer-supplier chain. It includes final market producers, and first, second and third tier suppliers that directly and indirectly engage in trade. It is comprised of multiple sectors or industries. (See Roelandt and den Hertog 1999). A &quot;Value-chain cluster&quot; is consistent with an &quot;industry cluster&quot; as defined by Czamanski and de Ablas (1979, p. 62): &quot;a subset of industries of the economy connected by flows of goods and services stronger than those linking them to the other sectors of the national economy.&quot; May also be defined as potential, where enterprises may or may not presently trade with each other, although such trade could possibly occur in the future.</td>
</tr>
<tr>
<td>Business network</td>
<td>&quot;A group of firms with restricted membership and specific, and often contractual, business objectives likely to result in mutual financial gains. The members of a network choose each other, for a variety of reasons; they agree explicitly to cooperate in some way and to depend on each other to some extent. Networks develop more readily within clusters, particularly where multiple business transactions have created familiarity and built trust (Rosenfeld 1995a, p. 13).” Ties between firms in networks are typically more formal than in clusters.</td>
</tr>
<tr>
<td>Italianate industrial district</td>
<td>A highly geographically concentrated group of companies that &quot;either work directly or indirectly for the same end market, share values and knowledge so important that they define a cultural environment, and are specifically linked to one another in a complex mix of competition and cooperation (Rosenfeld 1995b, p. 13). Key source of competitiveness are elements of trust, solidarity, and cooperation between firms, a result of a close intertwining of economic, social, and community relations. See also Harrison (1992).</td>
</tr>
<tr>
<td>Industry complex</td>
<td>&quot;A group of industries connected by important flows of goods and services, and showing in addition a significant similarity in their location patterns (Czamanski and de Ablas 1979, p. 62).&quot;</td>
</tr>
<tr>
<td>Innovative milieu</td>
<td>Not a group of business or a region, but a &quot;complex which is capable of initiating a synergetic process. . .an organization, a complex system made up of economic and technological interdependencies. . .a coherent whole in which a territorial production system, a technical culture, and protagonists are linked (Maillat 1991, p. 113).” See also Maillat (1988).</td>
</tr>
</tbody>
</table>