Transportation Systems and Information Technology: Pushing the Boundaries for Sustainable Outcomes

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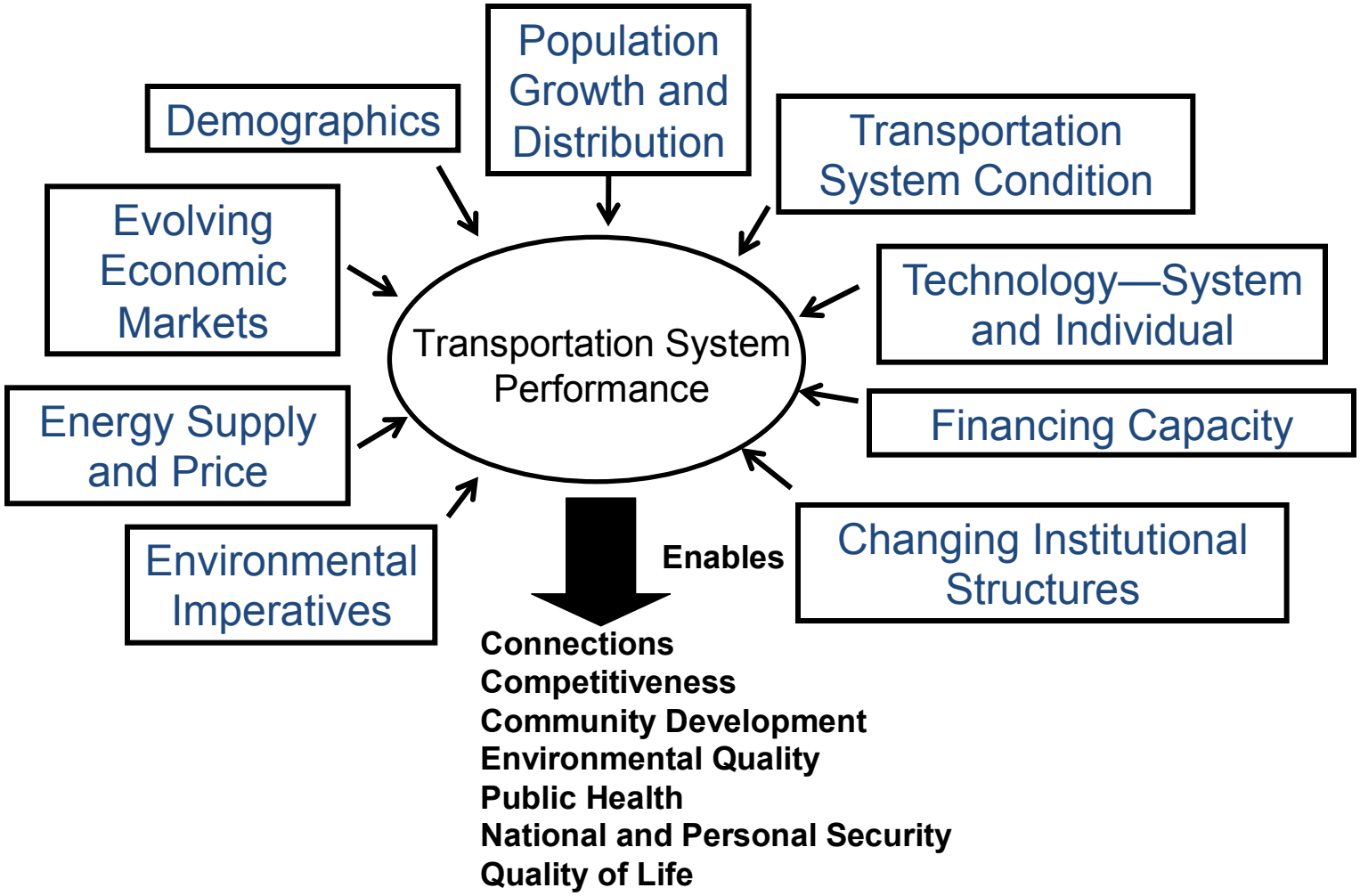
School of Civil and Environmental Engineering
Georgia Institute of Technology

Change Variables



European Union Council of Ministers of Transport, defines a sustainable transportation system as one that:

- Allows the basic access and development needs of individuals, companies and society to be met safely and in a manner consistent with human and ecosystem health, and promotes equity within and between successive generations.

- Is affordable, operates fairly and efficiently, offers a choice of transport mode, and supports a competitive economy, as well as balanced regional development.

- Limits emissions and waste within the planet's ability to absorb them, uses renewable resources at or below their rates of generation, and uses non-renewable resources at or below the rates of development of renewable substitutes, while minimizing the impact on the use of land and the generation of noise.

“A sustainable transportation system strives to achieve objectives including, but not limited to, the following:

- Reinforce livable and economically strong communities,
- Encourage modal choice throughout the state,
- Support efficient land uses that reduce travel distances and increase travel options,
- Distribute system benefits and burdens equitably across society,
- Be affordable,
- Improve safety to reduce injuries and fatalities,

According to the Oregon DOT

- Reduce emissions of greenhouse gases,
- Protect air and water quality from pollutants,
- Operate with clean and fuel-efficient vehicles,
- Use maintenance and construction practices that are compatible with native habitats and species and which consider habitat fragmentation concerns,
- Minimize raw material use and disposal during construction and maintenance, and
- Apply life-cycle costs to transportation investments."

Science Innovation Business Council – Transportation

"…. bring together experts from computer science, geographic information science, intelligent transportation systems, computer graphics, cognitive science, politicians, freight and logistics companies in order to collaborate for providing transport solutions that best meet the needs of the citizens and economies in Europe whilst minimizing damage to our environment…."

Key-Challenges:

Transport safety	Fuel dependency
Vehicle emissions	Network congestion
Standards	Smart vehicles

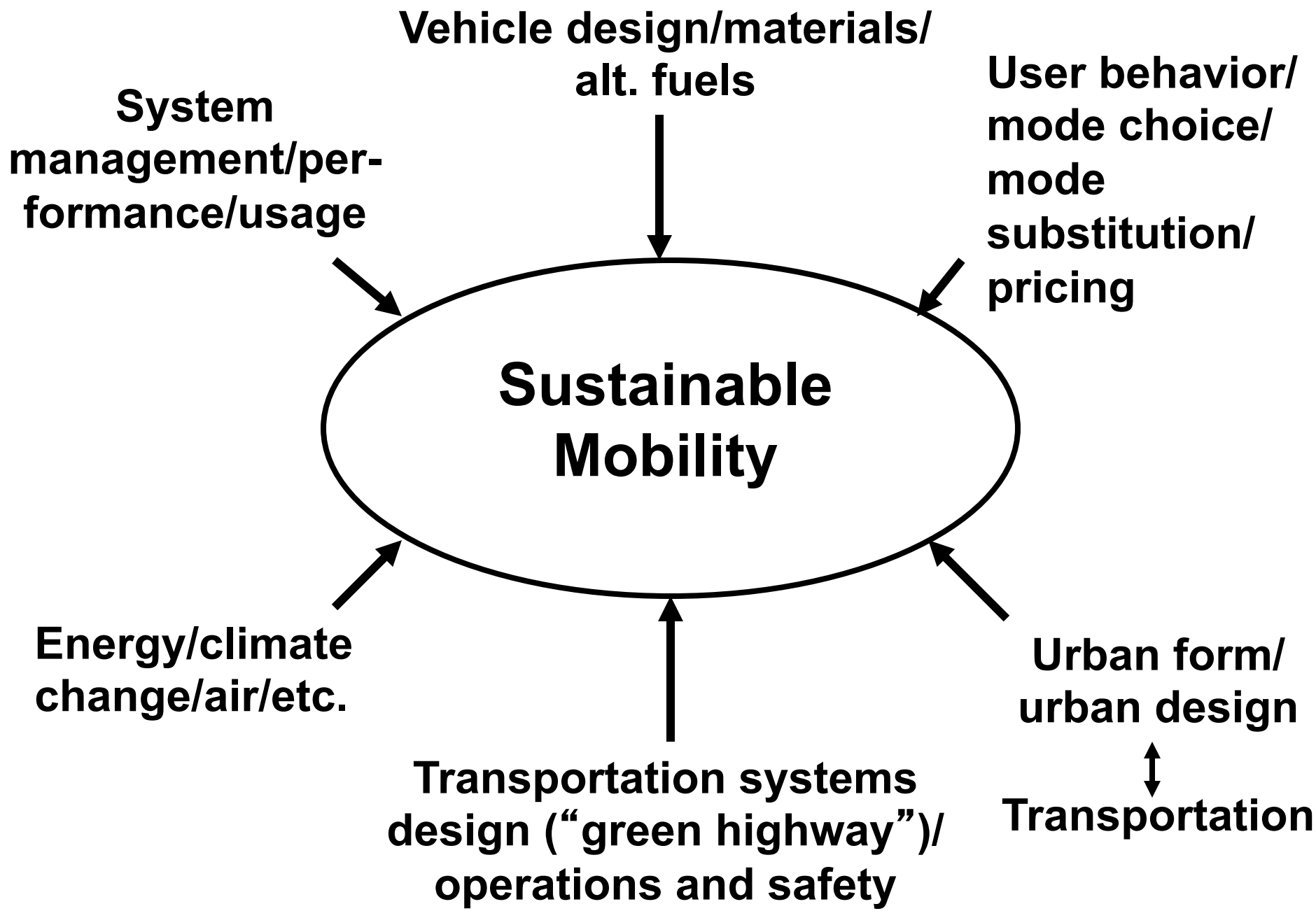
Fleet and freight management

Science Innovation Business Council –Future Cities

“….bring together experts from computer science, architects, civil engineers, urban planners, geographic information science, intelligent transportation systems, computer graphics, cognitive science, local governments, in order to collaborate for finding ways in which information technology can be used to improve our living environment….”

Key-Challenges:

- Demographic shift and urbanization
- Geo-sensor networks, local vs. global operations and analysis in the network;
- Urban mobility;
- City planning;
- Uncertain information distributed among moving travelers/vehicles and the infrastructure;
- Coordinated and collaborative transport across modes of traveling;
- Information regarding transfers to alternate modes of transportation;
- Data mining techniques for travel information, energy conservation and environmental impact and inference of behavior;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Urban form/
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Transportation systems
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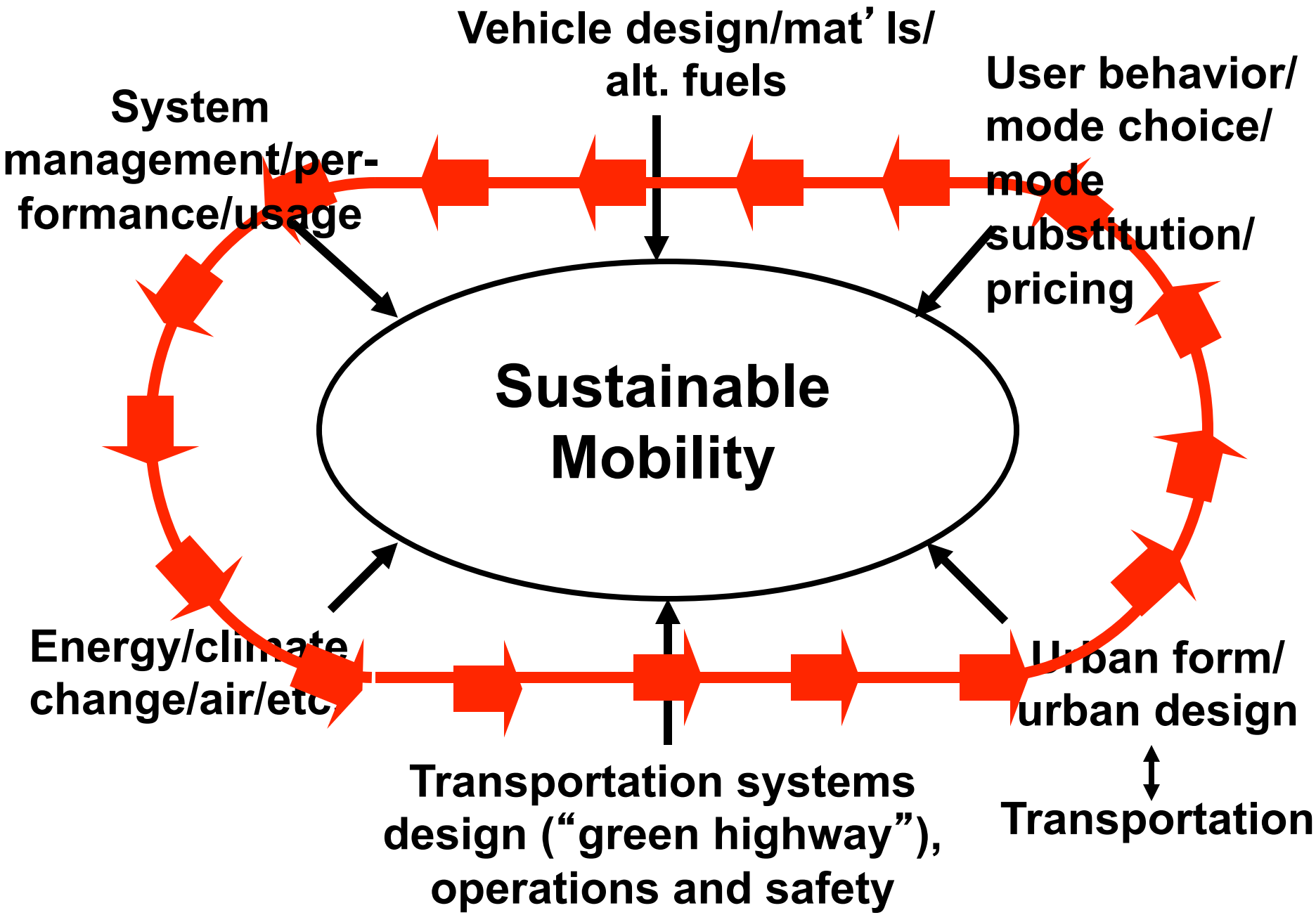
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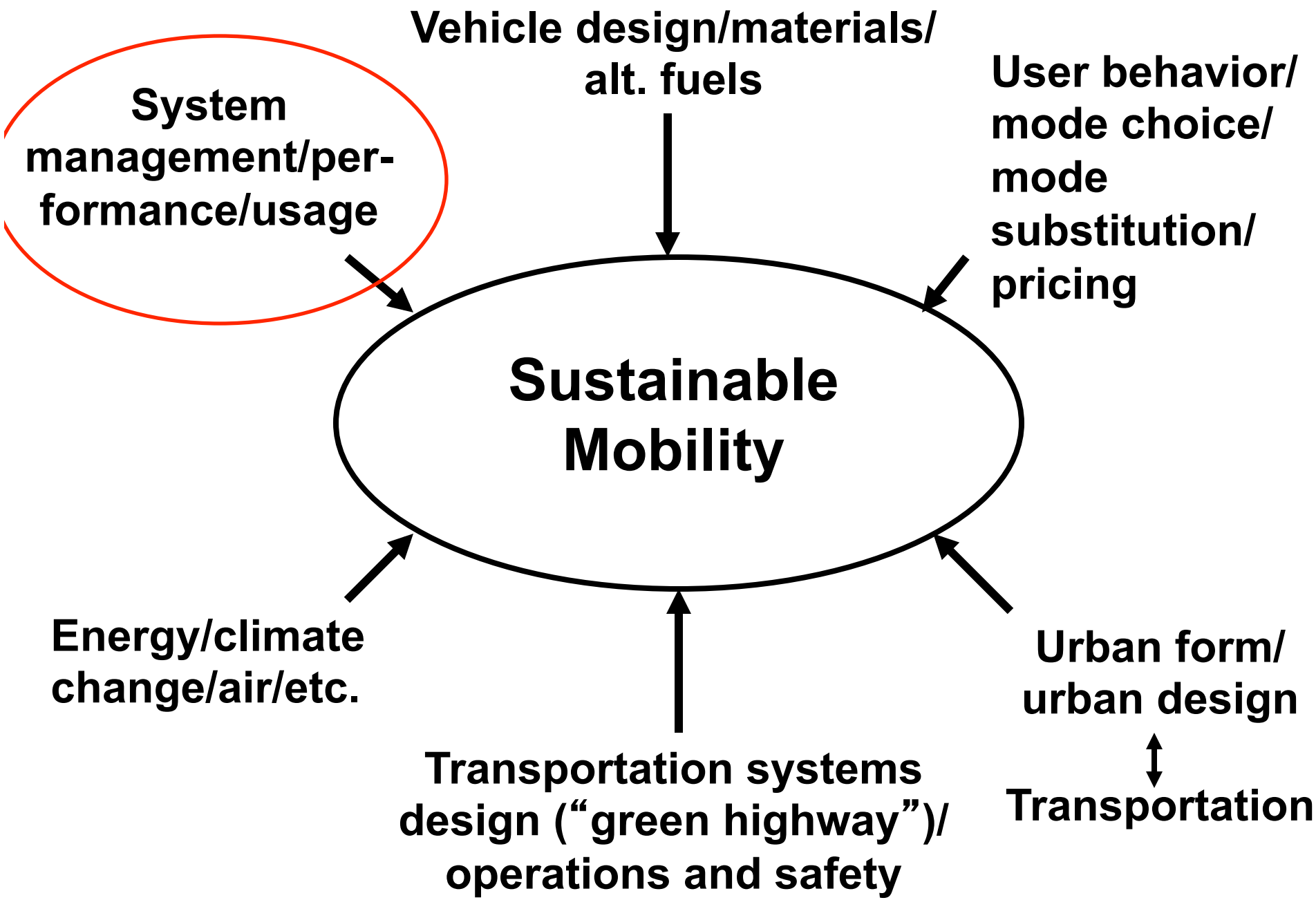
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System/Network Operations Management Under Dynamic Conditions

Transportation for America

A White Paper by Transportation for America, ITS America, the Association for Commuter Transportation and the University of Michigan's SMART Initiative.

WHITE PAPER

Smart Mobility for a 21st Century America

Strategies for Maximizing Technology to Minimize Congestion, Reduce Emissions and Increase Efficiency

Making transportation systems more efficient.

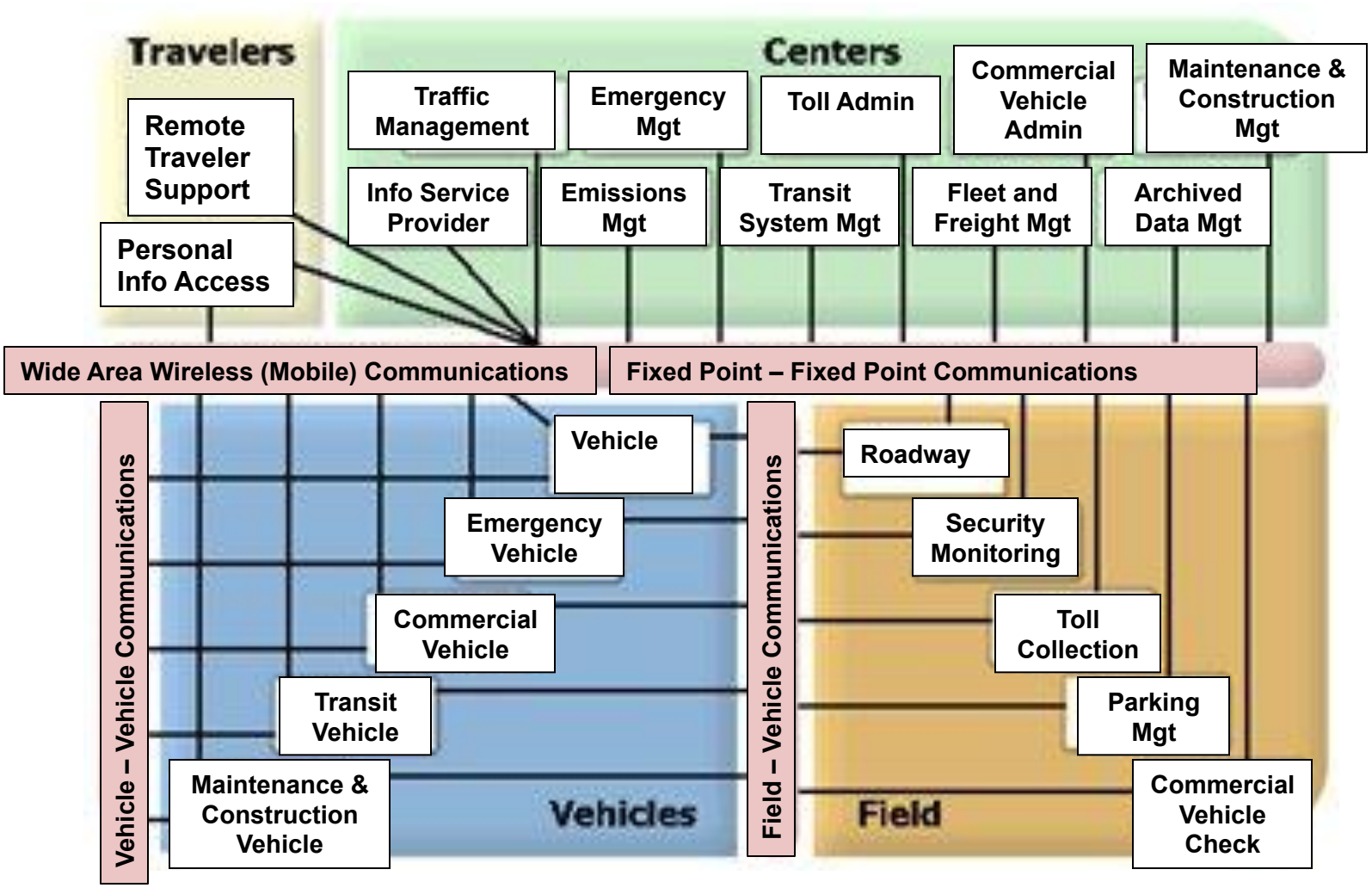
Providing more travel options.

Providing travelers with better, more accurate, and more connected information.

Making pricing and payments more convenient and efficient.

Reducing trips and traffic.

“While intelligent transportation systems (ITS) have begun to yield significant benefits, the full impact has yet to be realized because many technology solutions have been deployed in discrete segments rather than integrated throughout the whole system of transportation networks.”

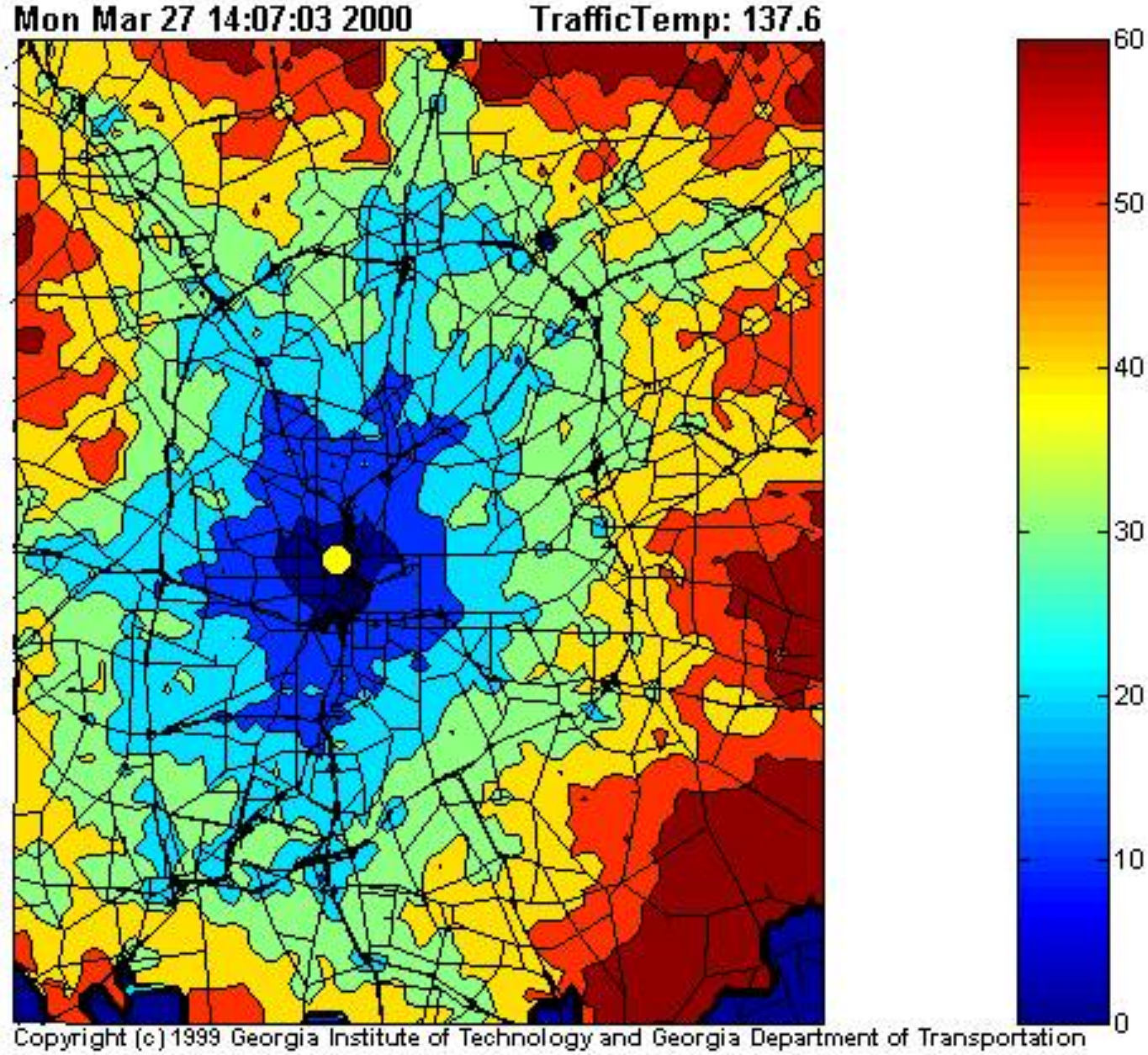

Travelers
Remote Traveler Support
Personal Info Access
Centers
Traffic Management
Emergency Mgt
Toll Admin
Commercial Vehicle Admin
Maintenance & Construction Mgt
Info Service Provider
Emissions Mgt
Transit System Mgt
Fleet and Freight Mgt
Archived Data Mgt
Wide Area Wireless (Mobile) Communications
Fixed Point – Fixed Point Communications
Vehicle – Vehicle Communications
Vehicle
Emergency Vehicle
Commercial Vehicle
Transit Vehicle
Maintenance & Construction Vehicle
Vehicles
Field – Vehicle Communications
Roadway
Security Monitoring
Toll Collection
Parking Mgt
Commercial Vehicle Check
Field

System/Network Operations Management Under Dynamic Conditions

- Incredible amounts of real-time data being collected from transportation system users that can be used for adjustments in system operations (to reduce congestion, reduce air emissions, etc.) How to use this data?
- Flexible scheduling for goods movement, emergency response fleets (and perhaps passenger fleets) based on data being collected on system performance—more ubiquitous application than used today.
- Much wider application of vehicle-to-vehicle data exchange for everything from crash avoidance to routing.
- Wireless, individual trip aids that promote "most efficient" path finding.

System/Network Operations Management Under Dynamic Conditions

- From a multimodal systems perspective, data management processes, operational practices, standards, integration, and rules for data exchange and sharing.
- Multi-source data base development, that is, data from multiple modes, performance environments and environmental factors. (from ITS strategic plan)
- Combined metropolitan-level information development from private transportation firms and passenger vehicles
- Human – information interface: comprehension, utilization, effectiveness for informing decisions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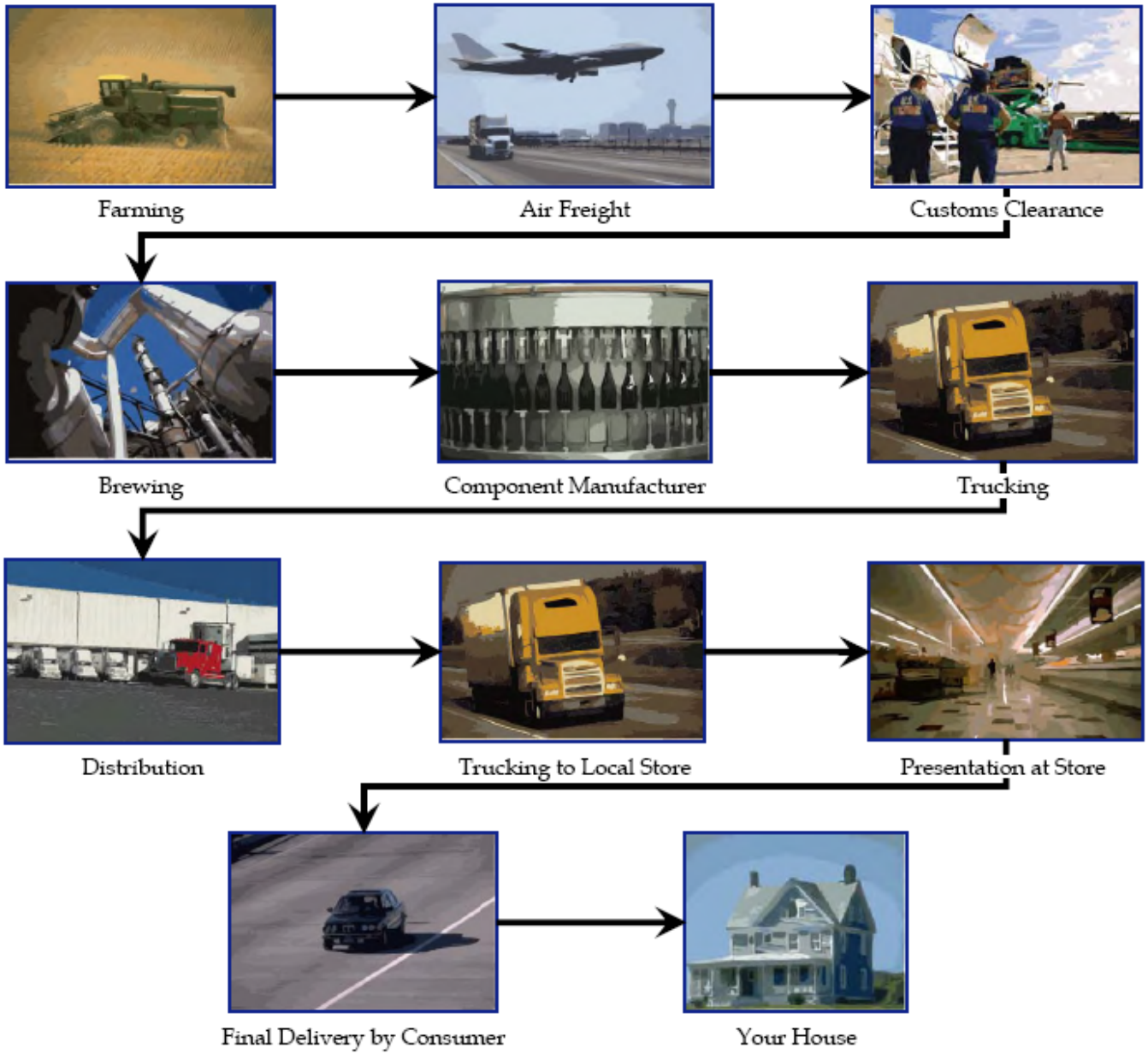
Beer Supply Chain



The “Resilient” Network and “Smart” Assets

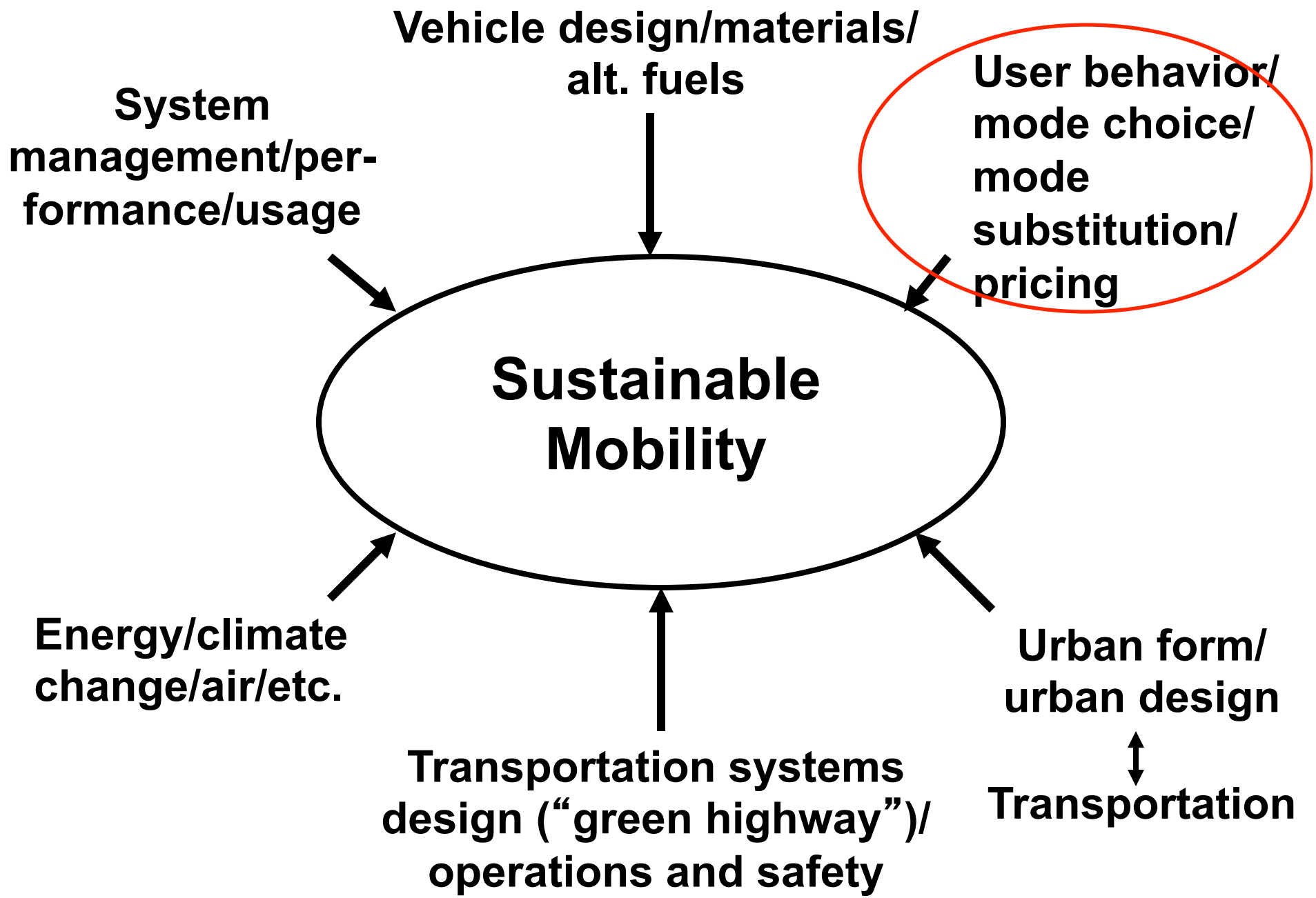
- Real-time sensing of changing “external” conditions and asset (as in materials) response.
- Real-time monitoring of capacity availability (e.g., parking) and dynamic routing before or during trip.
- More sophisticated levels of technology deployed in vehicles that provide input into centralized response strategies.
- But perhaps command and control passed from central traffic management centers to the users of the system.
- Large-scale simulation models to estimate most cost effective and environmentally sound response to disruptions (bouncing back).

“Little Brother”

- Large scale and comprehensive monitoring/scanning of transportation system users (freight and passengers).
- Large scale and real time monitoring that tracks movement of goods through supply chain (more so than today).
- More integrated and comprehensive (and perhaps invasive) monitoring of transportation employees (maybe biometric monitoring?)
- Global database integration and protocols for sharing data and monitoring movements from origin to destination.
- Real-time vehicle monitoring for compliance (yeah, right)

Transportation (Complex) Systems Modeling

- Large scale simulations of system conditions under dynamic stresses, including every potential user of the system.
- Interactions between transportation system and external (to transportation) factors, e.g., emissions, energy, land use, etc.
- Integrated, multi-modal modeling that shares information and can be used for optimal scheduling and routing, and for minimizing environmental harm.
- Need new knowledge and fundamental understanding emerging relationships, e.g. climate change.
- Visualization techniques of modeling results….after all, everyday folks are often the decision makers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System/Network Information Interface With Transportation Users

- Personal travel aides --- wireless, and integrated into a total communications package (cell phone or whatever it will be in the future).
- Monitoring of people movement instead of vehicle movement? How to use such data?
- More rapid and accurate information on system conditions and inducing traveler response….including not making a trip at all.
- Optimizing personal travel schedules and patterns based on system performance information.
- Customized information for different market segments, for example,…..

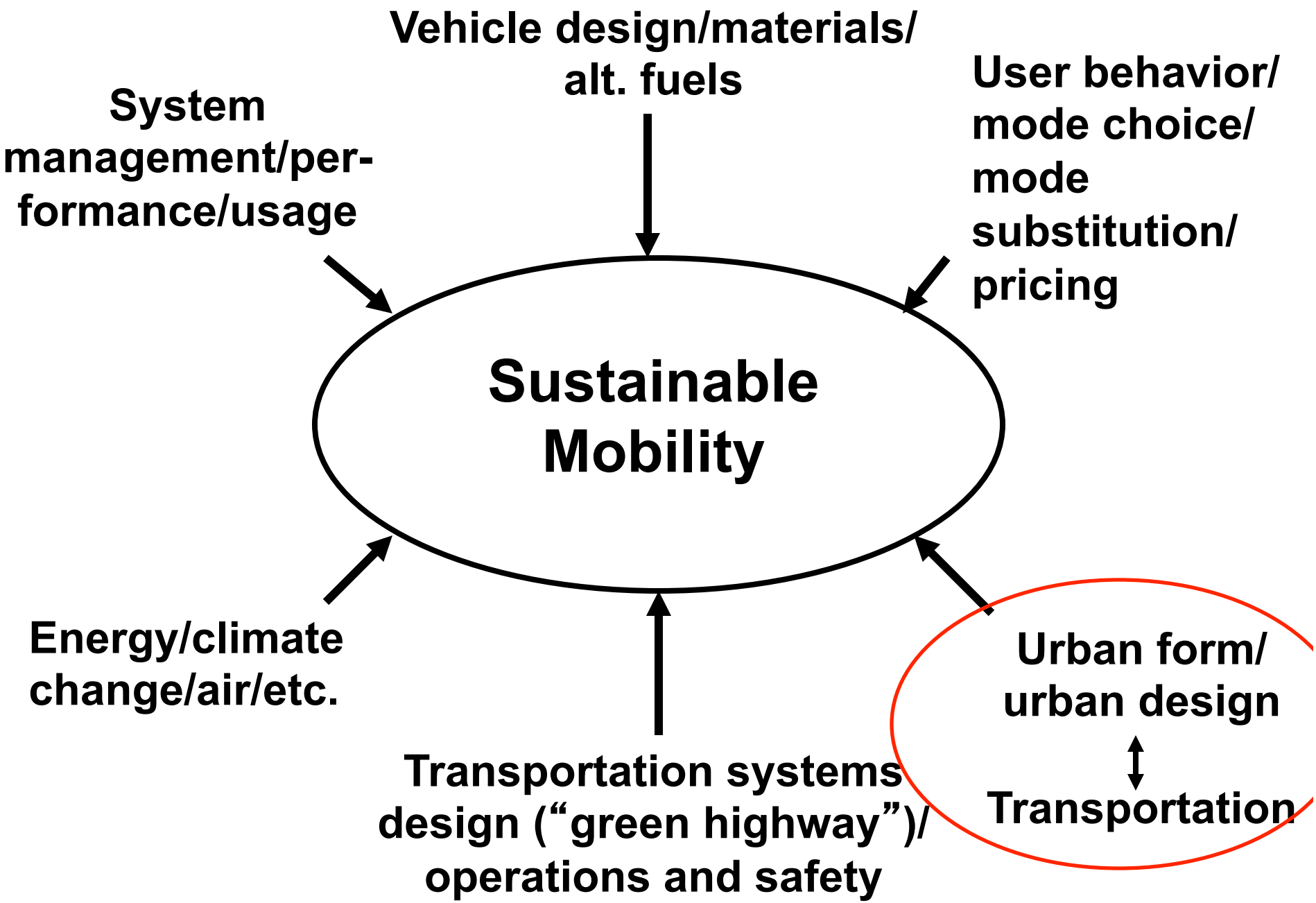
Aging of the Population

- In 2007, there were 31 million licensed drivers aged 65 and older in the United States.

- People 65 and older are the fastest growing demographic in the United States, and, by 2030, a quarter of all licensed drivers will be in that age group.

- Boomers will begin turning 65 in 2011, and by 2030, one out of five drivers will be 65 or older — up from one in eight drivers today.

Pricing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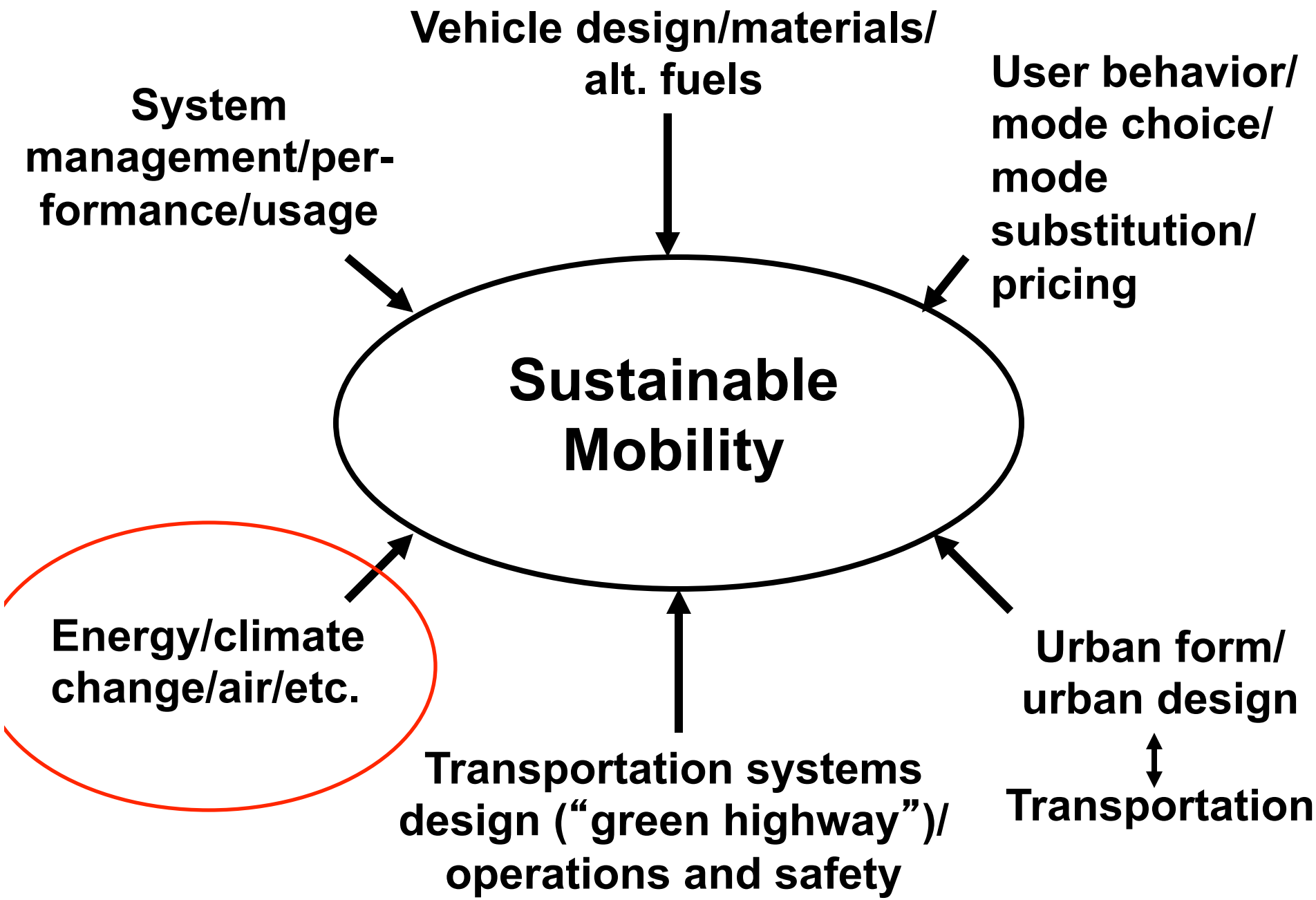
The "Connected" City

- More ubiquitous information availability on activities and trip-making possibilities in the city.
- Information from a total trip perspective – what is going on at the origin, along the way and at the destination → affects trip-making along many dimensions—timing, paths, modes, etc. Obvious need for sensors and information exchange.
- Standards, protocols, hierarchical structure for different data sources.
- IT and information availability as a substitute for movement.
- Interesting question – over the long term, what does the "connected" city look like? How is it different? How would people live in such a city?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Environmental Stewardship

- Real-time, information-based routing protocols and algorithms aimed at reducing greenhouse gases, energy consumption, etc. (already being done)
- In the long run, with alternative fueled vehicles, this might not be an issue.
- Environmental sensors that feed into self directed, "smart" asset/materials changes.
- Biodiversity metrics and real-time monitoring as they relate to transportation system performance.
- Modeling of the linkage between changing environment and transportation infrastructure, e.g., bridge scour.

“IT information refers to resources that either facilitates integration and participation according to the three constitutive parts of sustainable development (social, economic and environmental protection) and/or contributes to the strengthening of the process in which society is transformed according to the ideals of sustainable development.”

Adapted from J. Nolin, “Sustainable information and information science”