

# The Geography of Transport Systems

Jean-Paul Rodrigue

Sixth Edition



# Challenges for Transport Geography

## CHAPTER 10

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# The Geography of Transport Systems



Jean-Paul Rodrigue

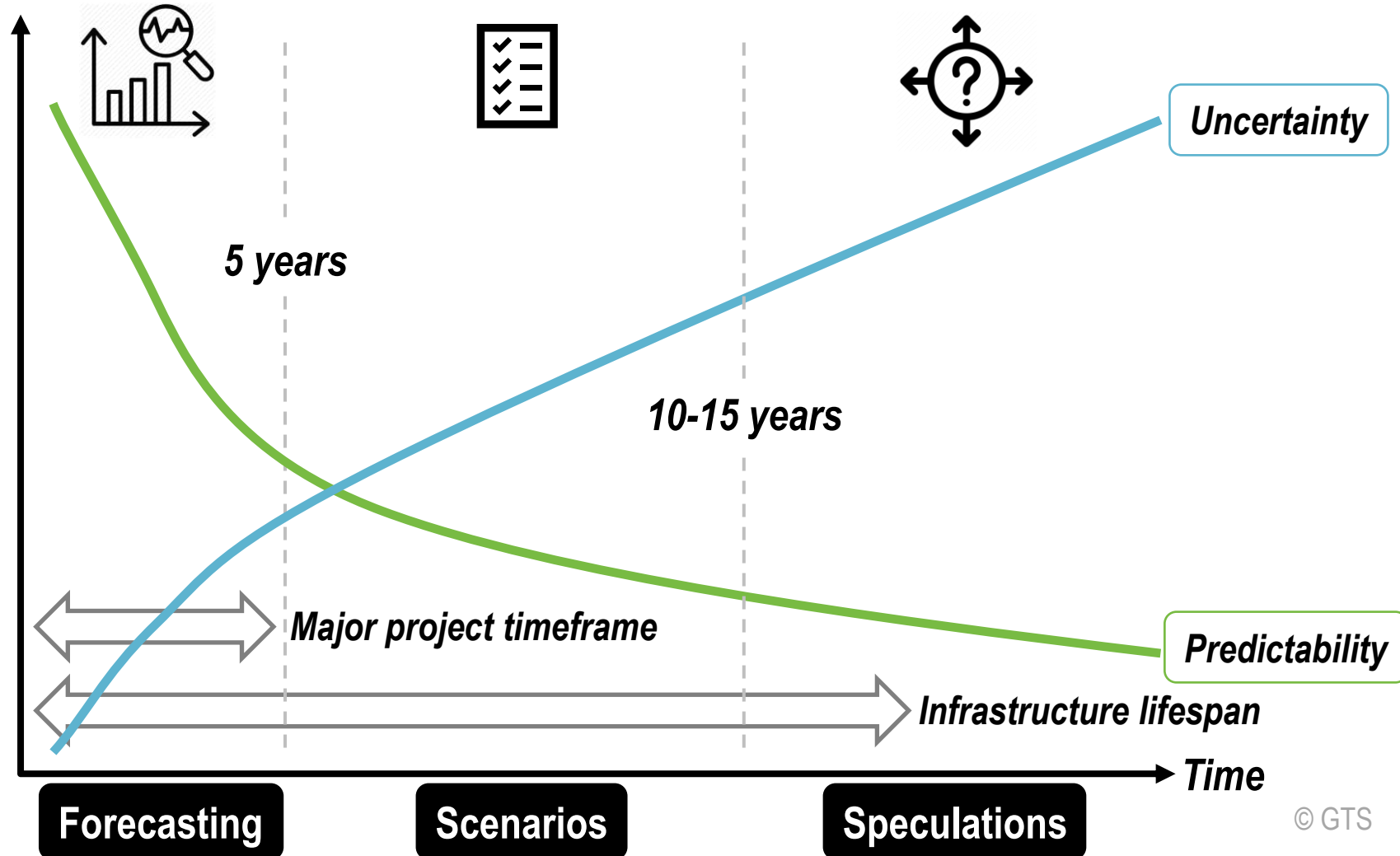
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# Future Transportation Systems

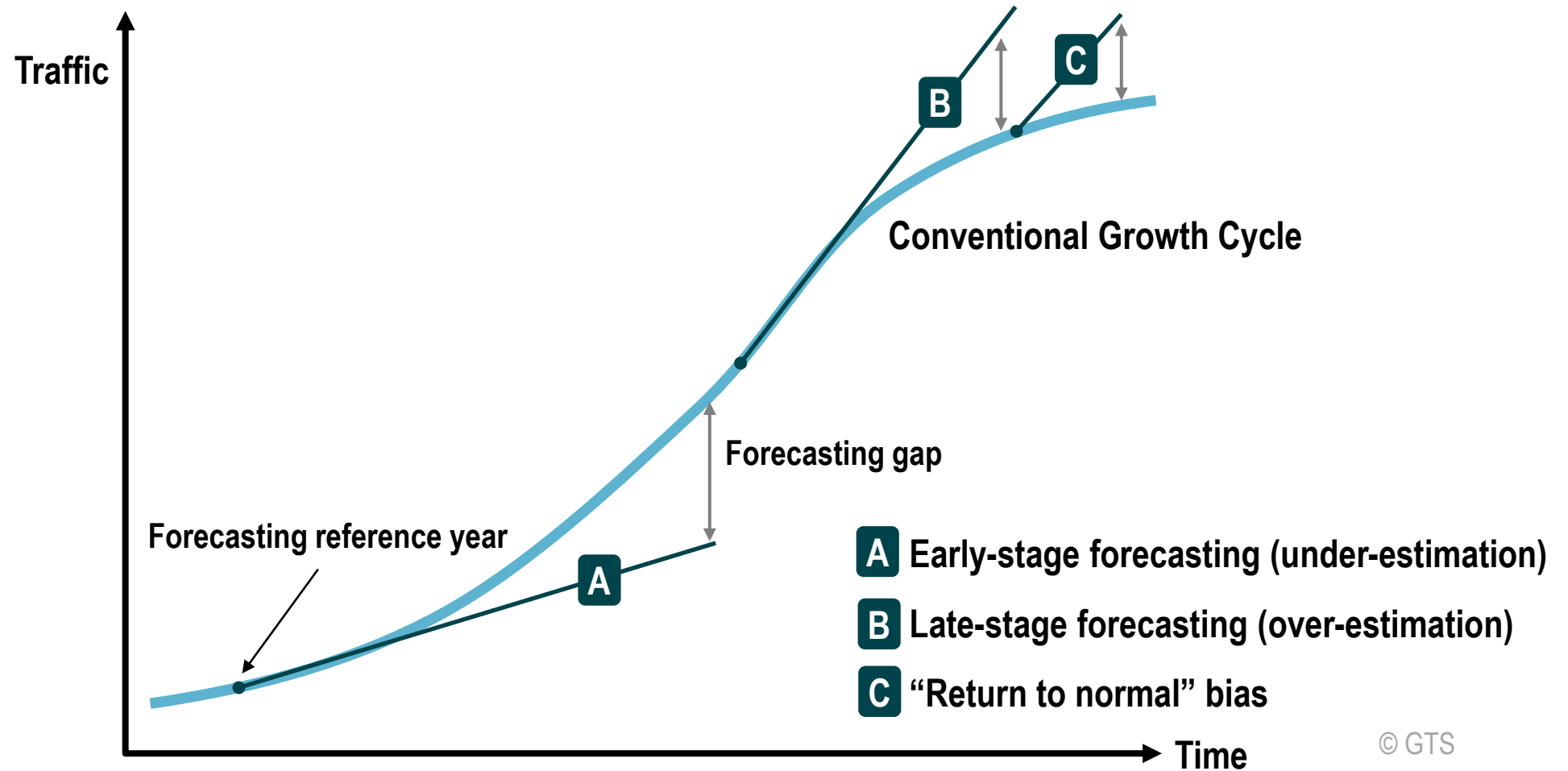
Chapter 10.4

# The Prediction of Future Outcomes

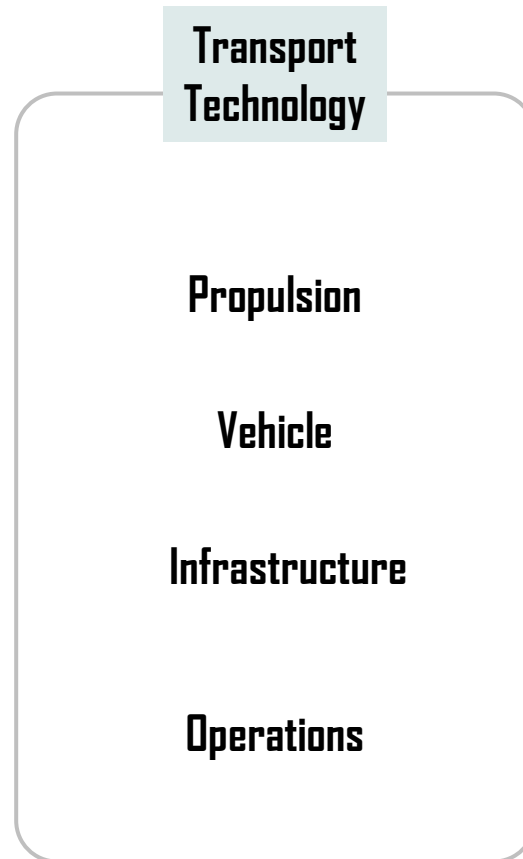


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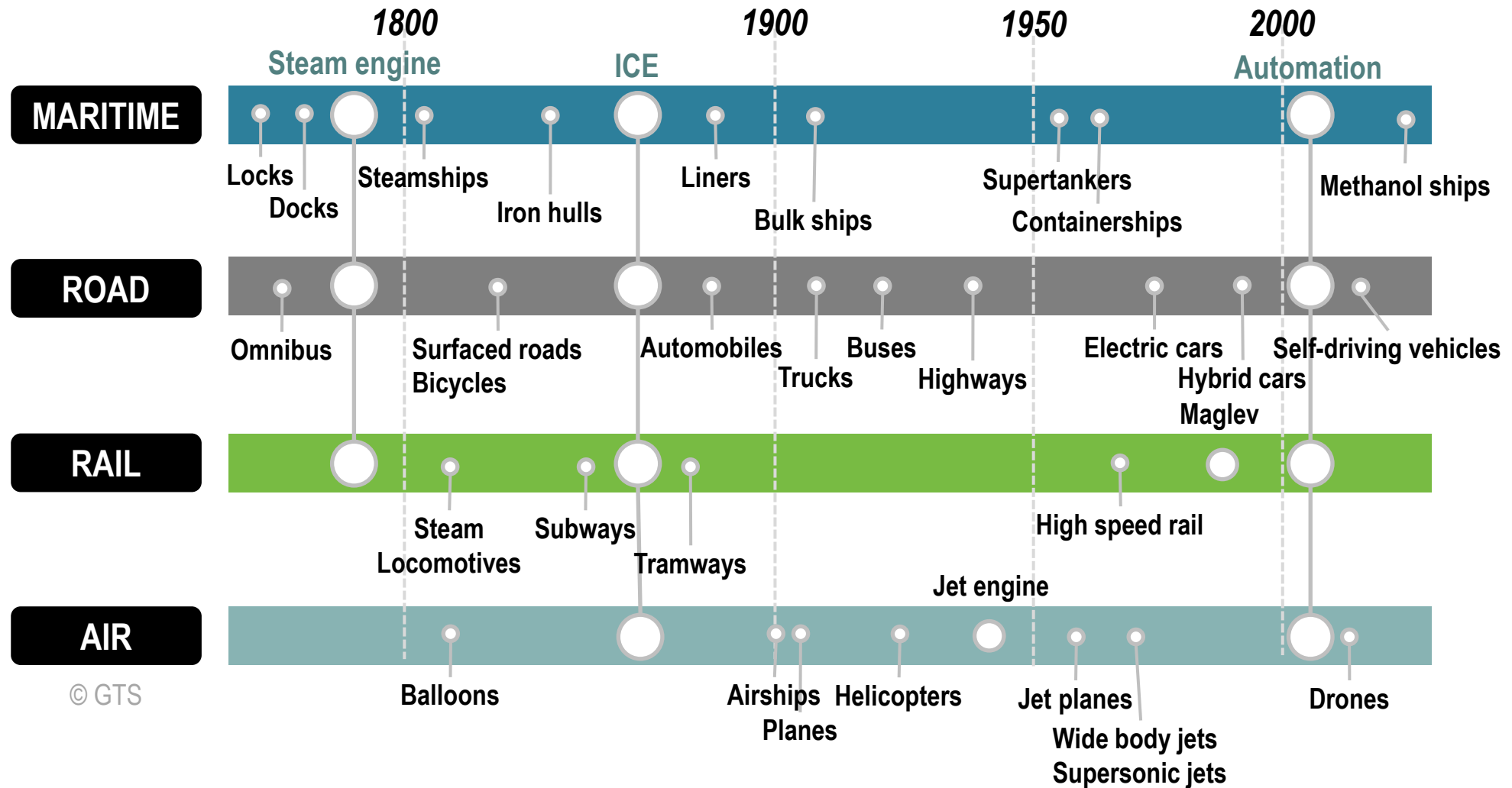
# Common Flaws in Forecasting



# Elements of Transport Technology



# Evolution of Transport Technology since the 18<sup>th</sup> Century



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# Major Technological Improvements in Transportation, Second Half of the 20th Century

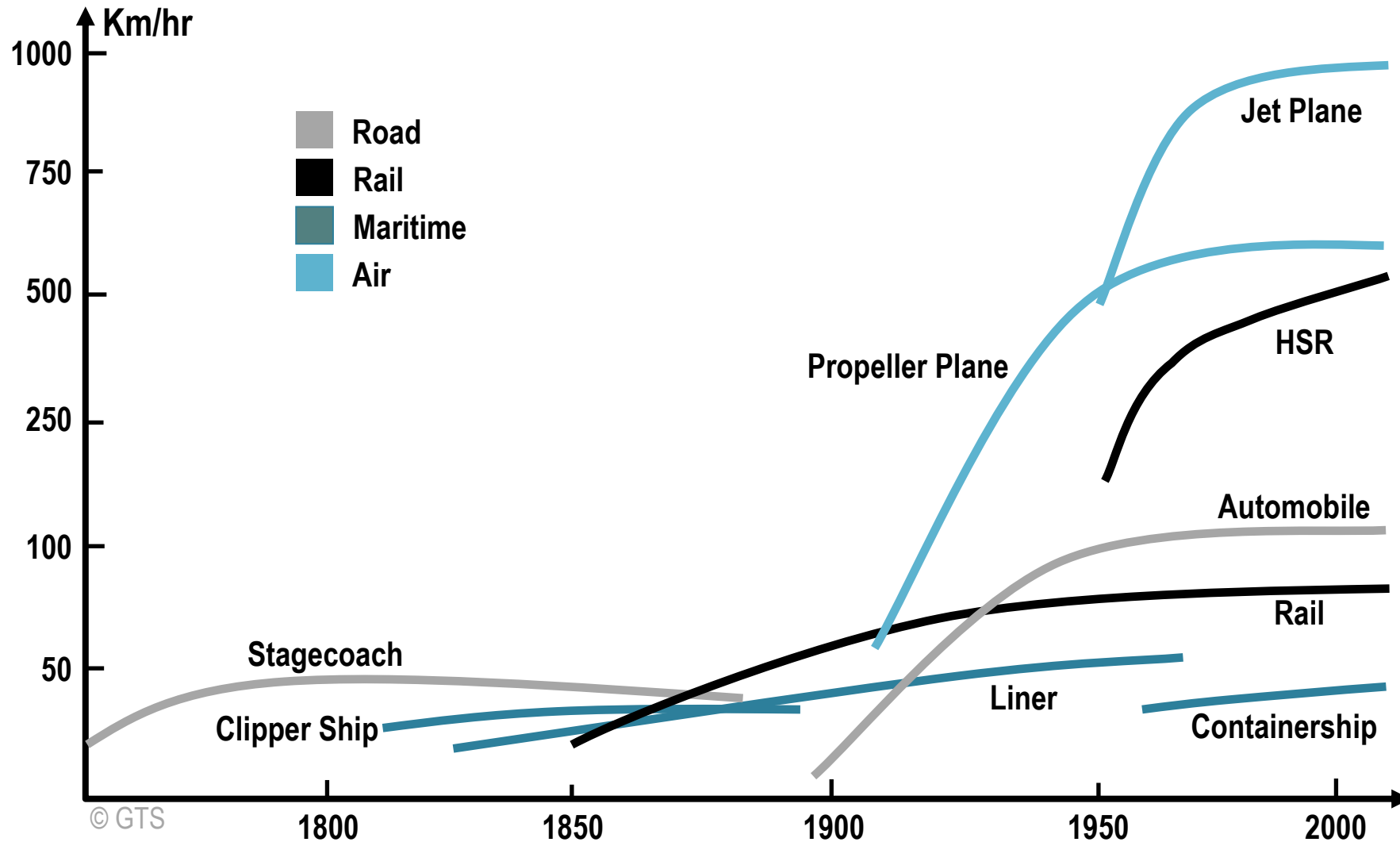
Innovation	Characteristics	Role
Superships (1960-)	Bulk and tank vessels with a mass up to half a million deadweight tons.	Reduce transport costs through massive economies of scale.
Container vessels (1968-)	Vessel specifically designed to carry containers.	Carry primarily manufactured goods with the capacity to interface with major land transport systems.
Jet aircraft (1958-)	Fast an non-stop services between major urban centers.	Linked with the development of service activities such as banking, finance and tourism.
Fuel-efficient vehicles (1970-)	Reduction in fuel consumption due to lower weight and more efficient engines.	Enabled highway transport to increase its share of urban an intercity transport.
High-speed trains (1964-)	Trains capable of moving at speed higher than 200 km/hr.	Effective competition between intercity air and road transport in high density areas.



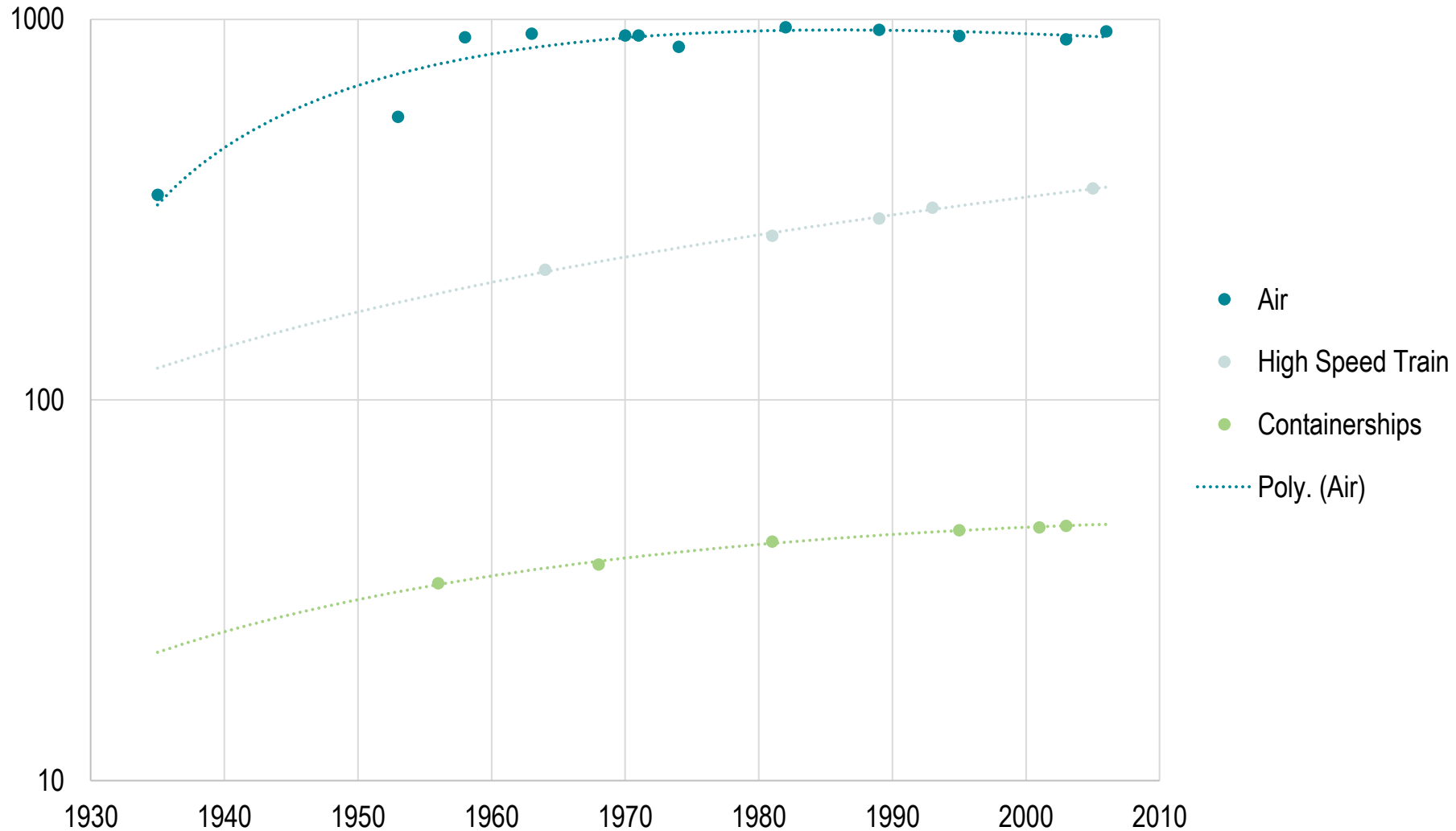
# Development of the UK Transport System, 1750-1990



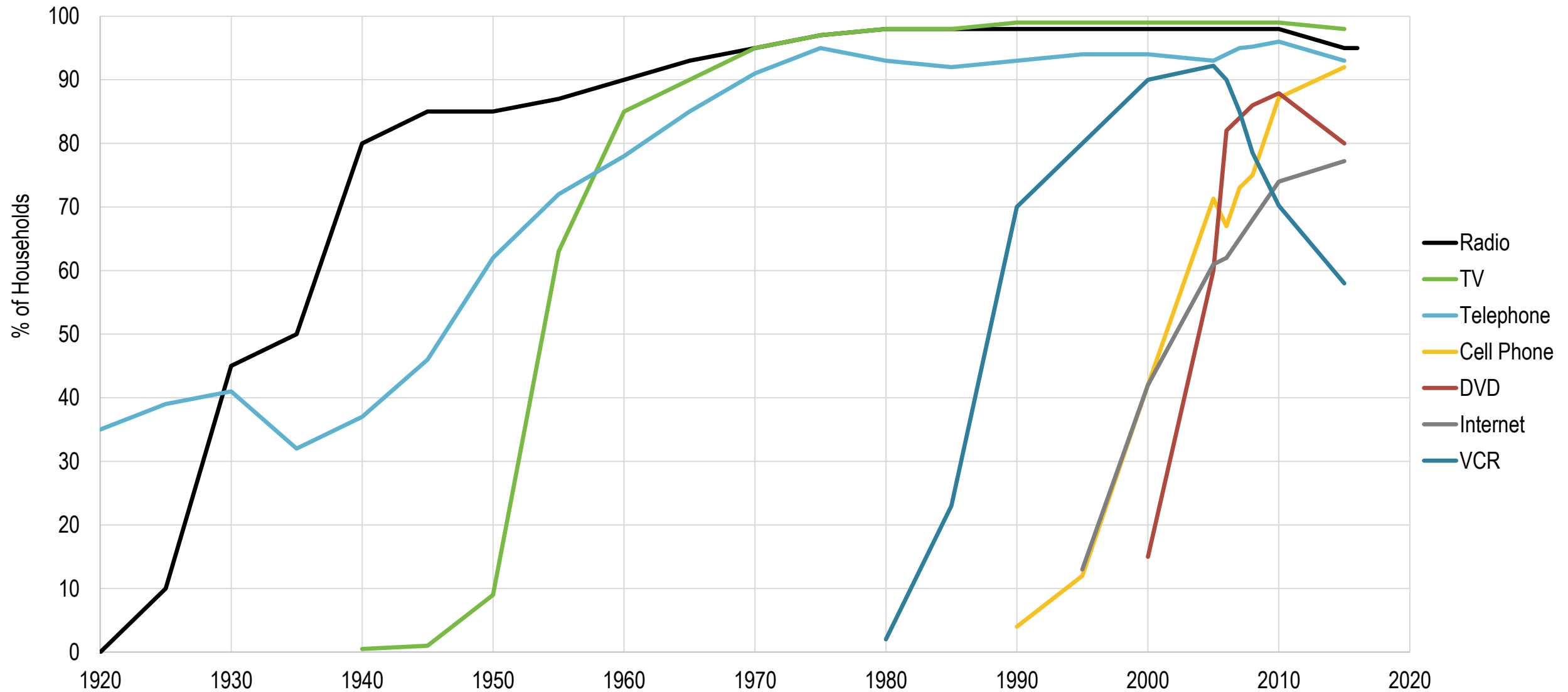
# Development of Operational Speed for Major Transport Modes, 1750-2020



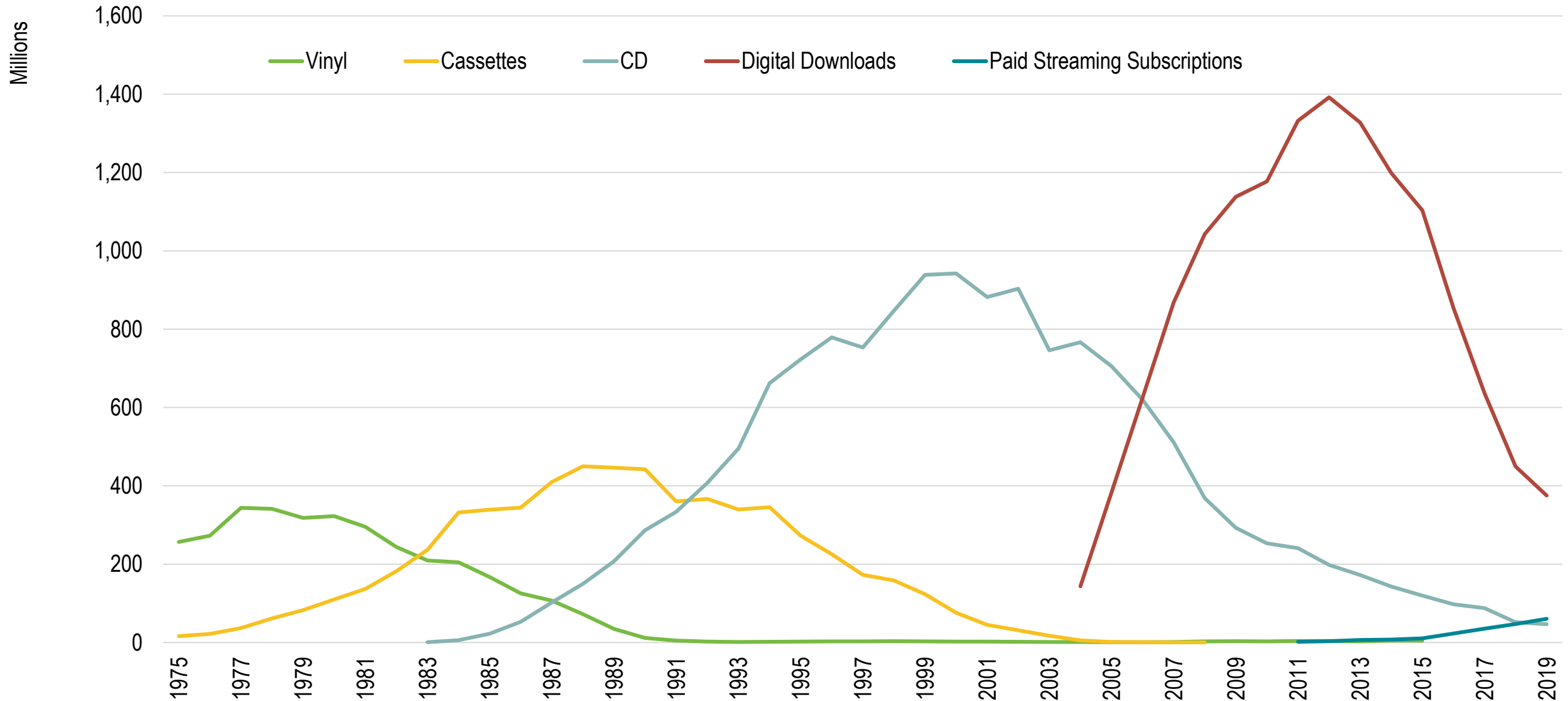
# Operational Speed of Contemporary Transport Modes



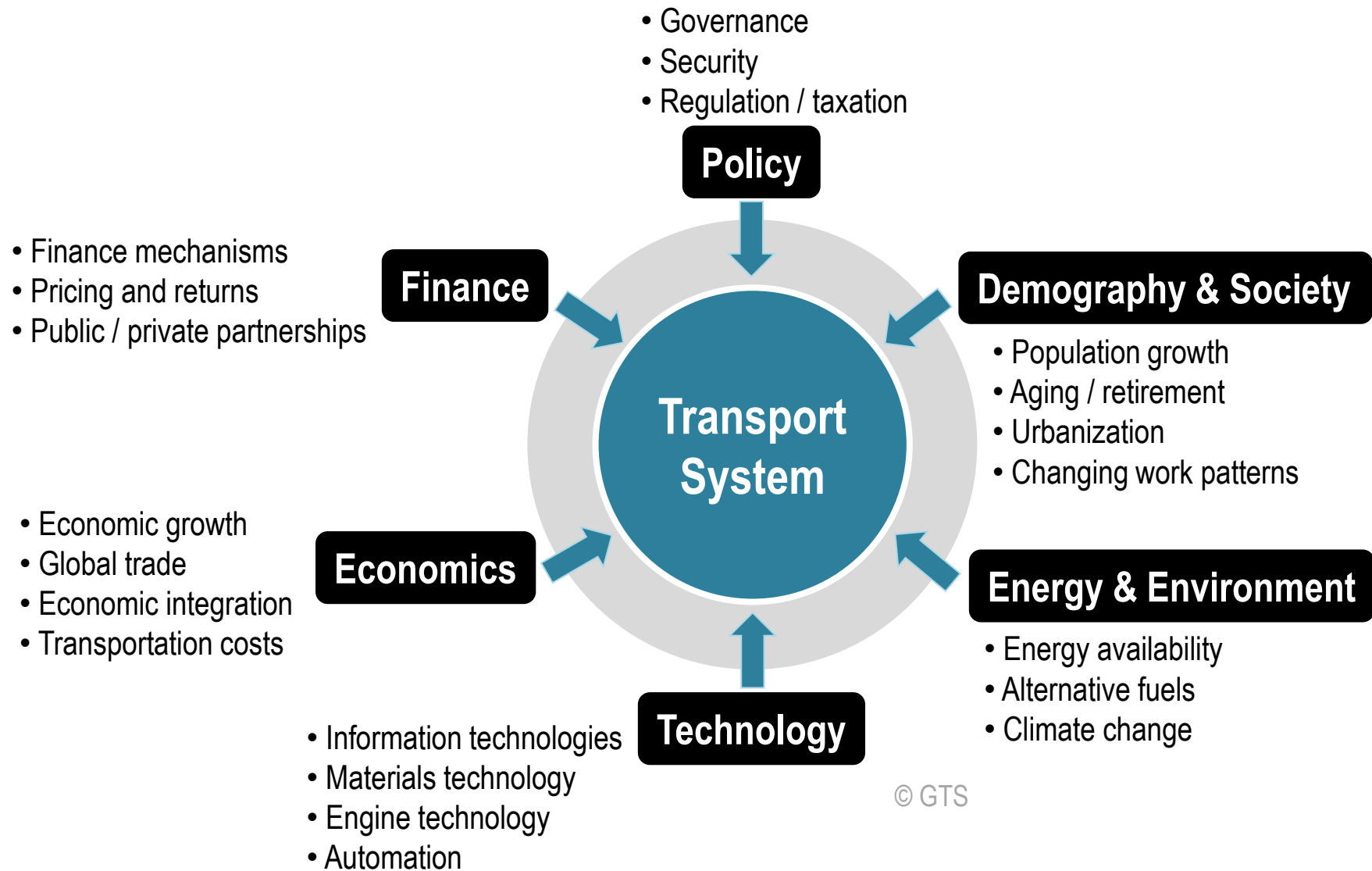
# US Household Penetration of Telecommunications, 1920-2020



# Music Sales in the United States, 1975-2019

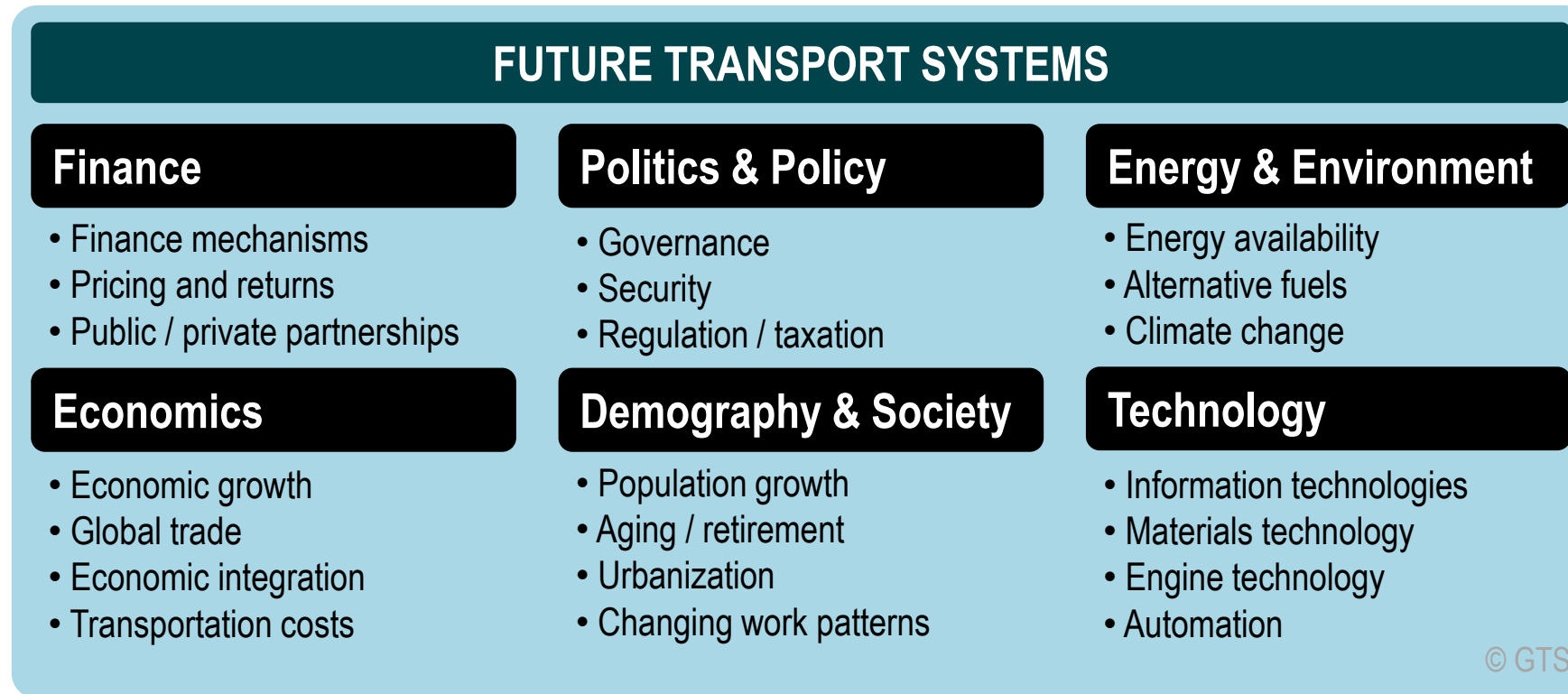


# Drivers of Change for Future Transportation



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# Drivers of Change for Future Transportation

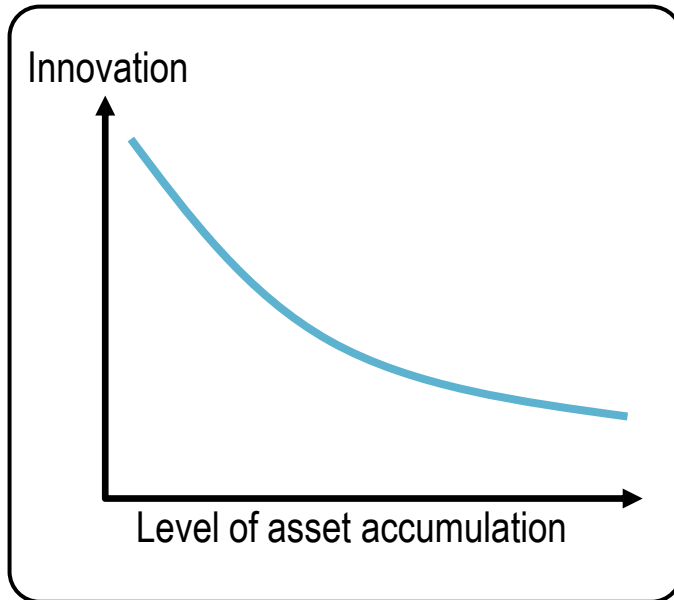


# General Impacts of Transport Innovations

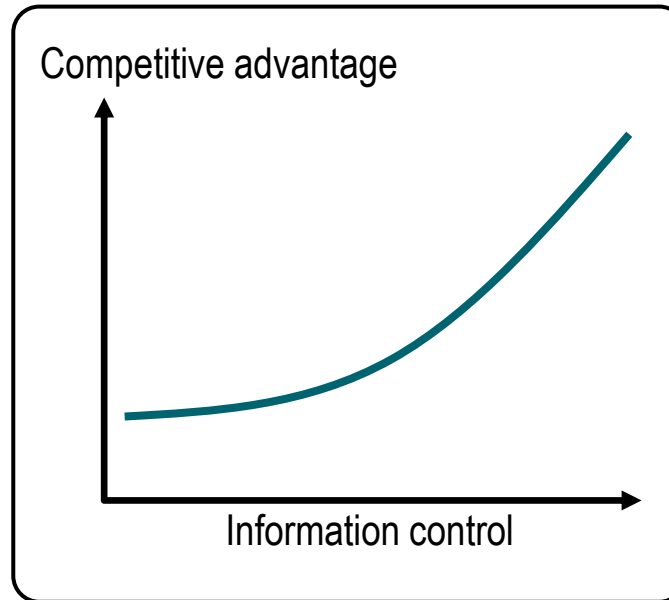
Field	Outcome
Travel time	Lower time and higher reliability
Trip planning	Easier to book and monitor
Environment	Less environmental impacts and noise
Energy	Lower energy consumption per unit carried
Assets	Higher level of utilization of modes and infrastructure
Safety	Reduced number of accidents, fatalities and injuries
Accessibility	Improved accessibility; reduced friction of distance
Cross-border	Improved throughput and security
Infrastructure	Longer life cycle, improved maintenance and reliability
Materials	New and recycled materials
Intermodal	Improved connections between modes



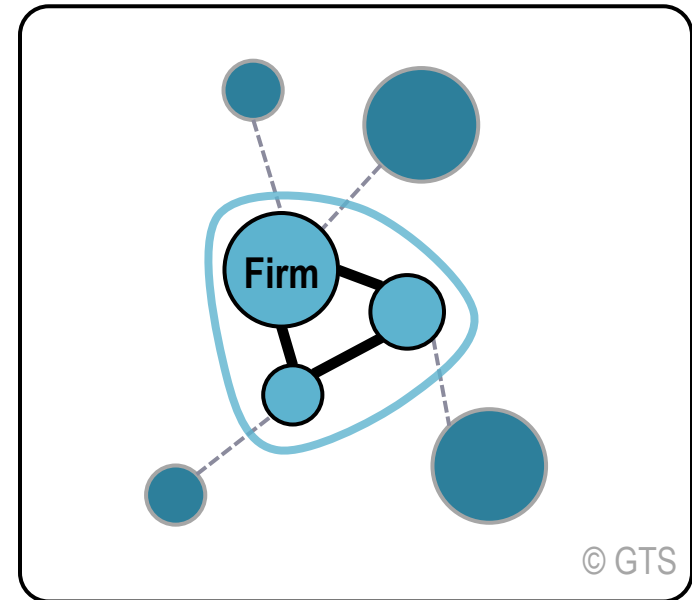
# Forces Shaping the Diffusion of Information and Communication Technologies in Transportation



**PATH DEPENDENCY**



**ASYMMETRY**

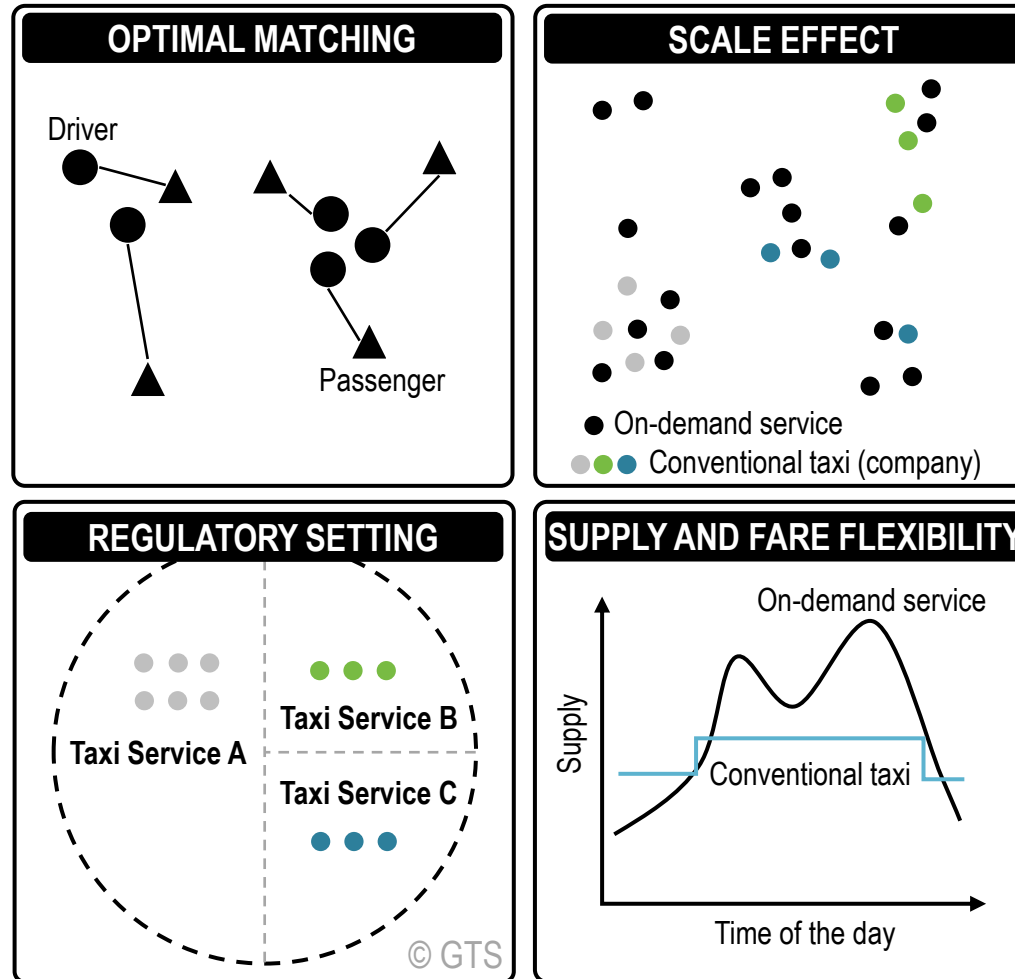


**INTERNALIZATION**

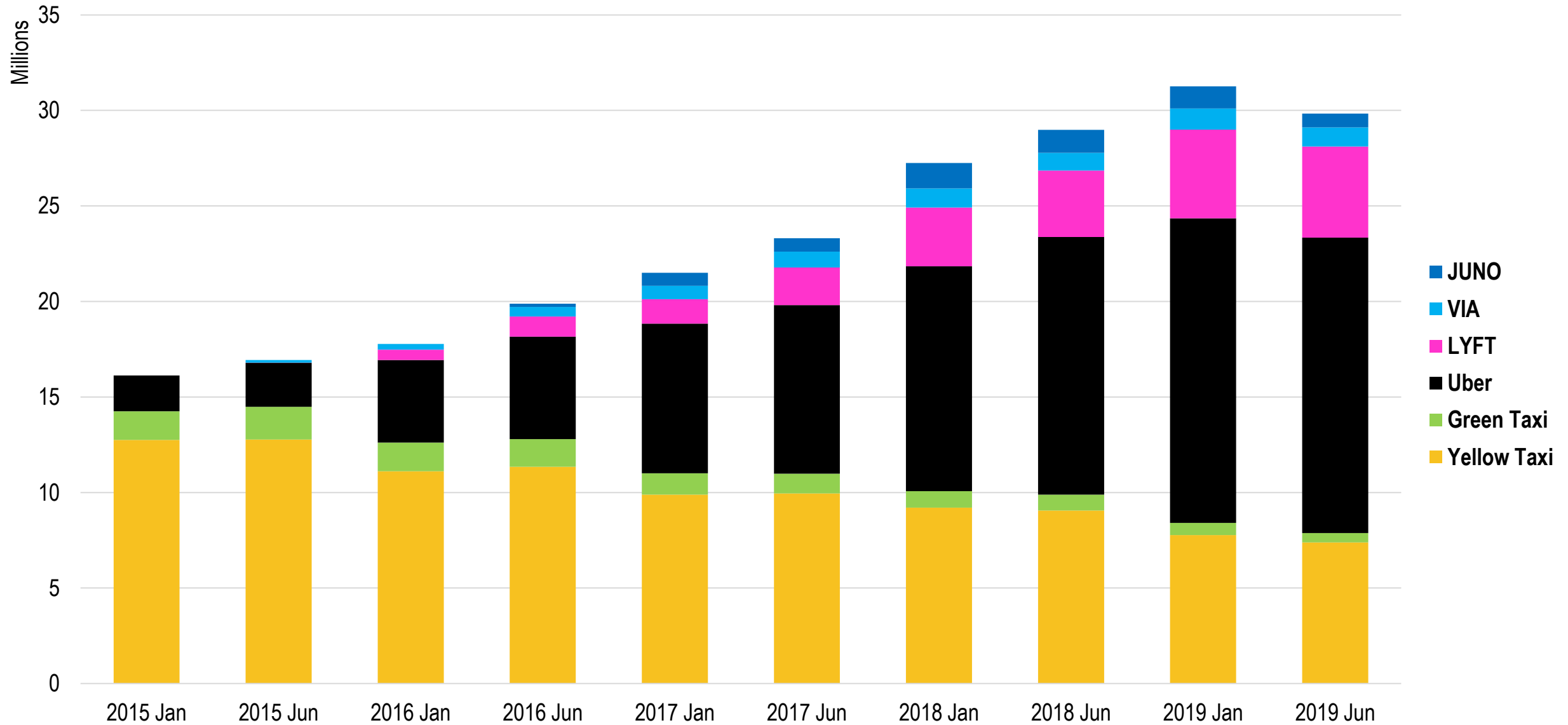
# Potential of Some Transport Innovations

Innovation	Perceived Benefits	Potential Beneficiaries	Cost Burden	Potential Supporters
Light Rail	Accessibility to CBD; Reduced emissions and energy used per pass. – km; Safety	New users; Developers; Landed interests along paths	Tax payers; Nearby residents	Transit industry; Drivers; Environmental groups; Passengers
Road Pricing	Reduced congestion and emissions	Drivers with high time value	Drivers	Environmental groups; Collecting institutions
Telecommuting	Reduced congestion and emissions; Time savings	Telecommuters; Commuters	Employers; Tax payers (if subsidized)	Environmental groups; IT industry; Commuters
Shared / on demand vehicles	Lower costs; Increased mobility, better usage of existing vehicle assets	Commuters; Users; People without vehicles	Taxi industry; Transit industry	Passengers; IT industry

# Potential Benefits of On Demand Vehicles Compared with Conventional Taxi Services















# Number of Monthly Trips by for Hire Services, New York City, 2015-2019



# Forms of Transport Automation

Automation Level	Modes	Terminals (Loading / Unloading / Storage)
None (Level 0)	All driving functions assumed by user.	All functions assumed by manually operated equipment.
Basic (Level 1)	Driving assistance (e.g. cruise control), but user responsible for core driving functions.	Operation assistance (location of drop-off, storage and pick up), but manually operated equipment.
Partial (Level 2)	Some driving tasks (e.g. steering, acceleration, deceleration). User monitors environment and ready to take control.	Planning and managing the use of equipment and storage space (Warehouse and yard management systems).
Conditional (Level 3)	Perform most driving tasks and monitors driving environment. User must be ready to take control at request.	Semi-automatic equipment (cranes, gantries, storage stacks). Automated access to facilities (automated gates).
High (Level 4)	Performs all driving tasks and monitors controlled driving environment. User does not need to take control.	Integration between automated handling and storage systems (Fully automated terminal or warehouse). Automated pick-up and deliveries.
Full (Level 5)	Autonomous vehicle; Performs all driving functions under all environments. User provides destination, but does not control vehicle.	Autonomous terminal; responds to demand (modal, intermodal, flows).

# Forms of Transport Automation

AUTOMATION LEVEL	MODES	TERMINALS
 <p><b>0</b>  None</p>	<p>All driving functions assumed by user.</p>	<p>All functions assumed by manually operated equipment.</p>
 <p><b>1</b>  Basic</p>	<p>Driving assistance (e.g. adaptive cruise control), but user responsible for core driving functions.</p>	<p>Operation assistance (location of drop-off, storage and pick up), but manually operated equipment.</p>
 <p><b>2</b>  Partial</p>	<p>Some driving tasks (e.g. steering, acceleration, deceleration). User monitors environment and ready to take control.</p>	<p>Planning and managing the use of equipment and storage space (Warehouse and yard management systems).</p>
 <p><b>3</b>  Conditional</p>	<p>Perform most driving tasks and monitors driving environment. User must be ready to take control at request.</p>	<p>Semi-automatic equipment (cranes, gantries, storage stacks). Automated access to facilities (automated gates).</p>
 <p><b>4</b>  High</p>	<p>Performs all driving tasks and monitors controlled driving environment. User does not need to take control.</p>	<p>Integration between automated handling and storage systems (Fully automated terminal or warehouse). Automated pick-up and deliveries.</p>
 <p><b>5</b>  Full</p>	<p>Autonomous vehicle; Performs all driving functions under all environments. User provides destination but does not control vehicle.</p>	<p>Autonomous terminal; responds to demand (modal, intermodal, flows).</p>

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		Value		
		Environment	Energy	Mobility
	<b>Mobility electrification</b>	Reduced emissions and better air quality	Additional decentralized energy resources (smart charging)	Reduced total cost of ownership of vehicles
	<b>Grid Edge Transformations</b>	Clean energy sources fuel electric miles	New resources for flexibility and stability of the electricity system	Earnings from electricity related services (V2X)
	<b>Mobility Transformations</b>	Efficient use of resources	More options to aggregate and shape charging patterns	Optimized vehicles utilization, additional reduction of costs and congestion
		<b>Greener cities</b>	<b>Optimized energy system</b>	<b>Cheaper urban mobility</b>

# Emerging Transportation Technologies

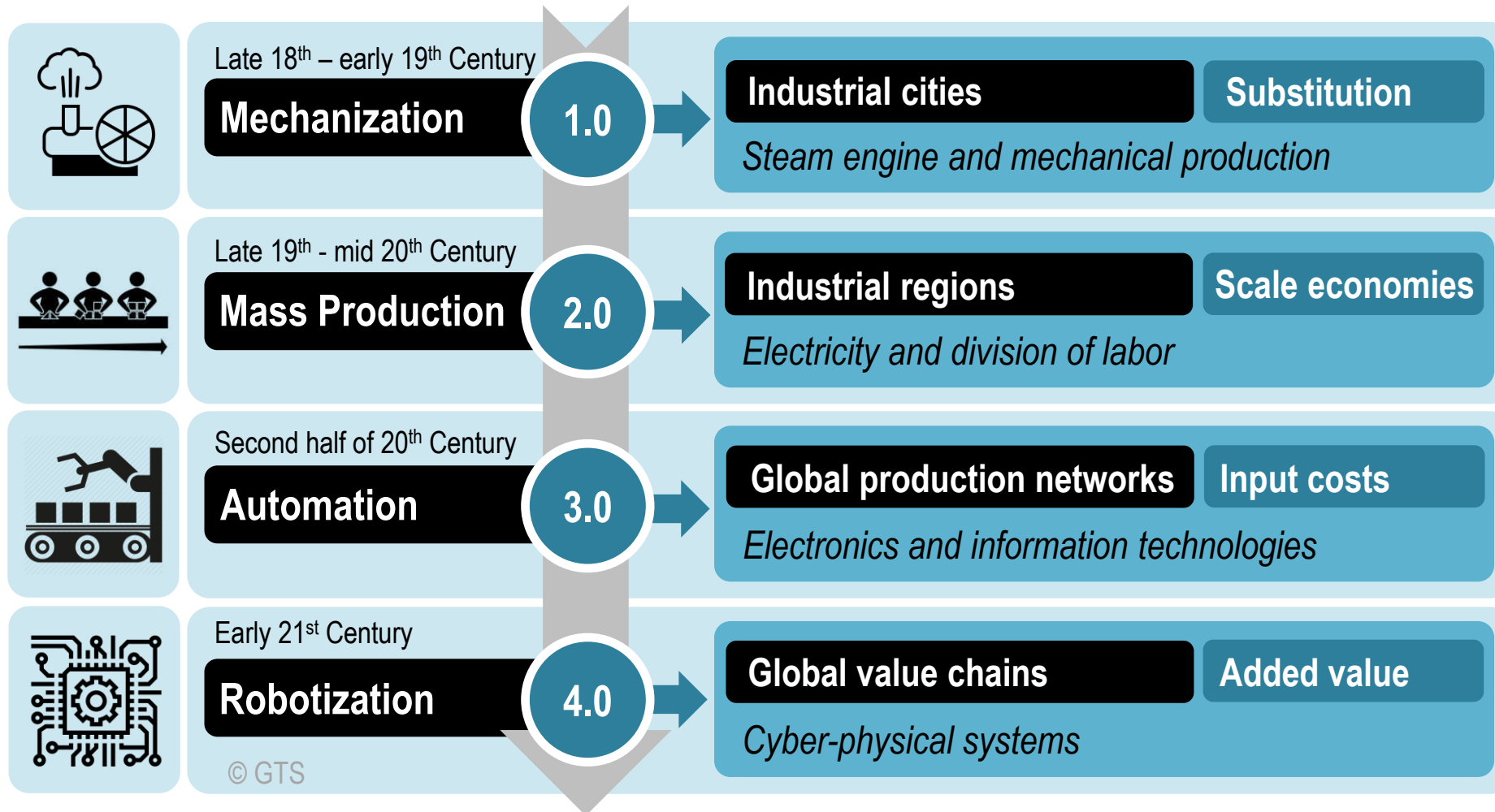
- 1. Connected vehicle technologies;
- 2. Advanced aviation systems;
- 3. High-speed rail technologies;
- 4. Advanced propulsion, alternative fuels and related infrastructure;
- 5. The “Internet of Things”;
- 6. Advanced analytics and machine learning;
- 7. Automated vehicles;
- 8. Unmanned aircraft systems (UAS);
- 9. Maritime autonomous surface ships (MASS);
- 10. Infrastructure inspection robots;
- 11. On-demand ride services: Transportation network companies;
- 12. Innovative concepts for protecting pedestrians, bicyclists and motorcyclists;
- 13. Wireless power transfer;
- 14. Additive manufacturing (3D printing);
- 15. Materials science in infrastructure;
- 16. Hyperloop;
- 17. Big data and energy-efficient computing;
- 18. Satellites and commercial applications of space;
- 19. Robotics and autonomous systems;
- 20. Agri-science;
- 21. Blockchain;
- 22. Augmented/virtual reality;
- 23. Airline New Distribution Capability;
- 24. Sensors and screening technology;
- 25. Advanced materials and nanotechnology;
- 26. Modern airships;
- 27. Ice-phobic materials;
- 28. Intelligent transportation systems;
- 29. Wearable technology; and
- 30. Energy and its storage.



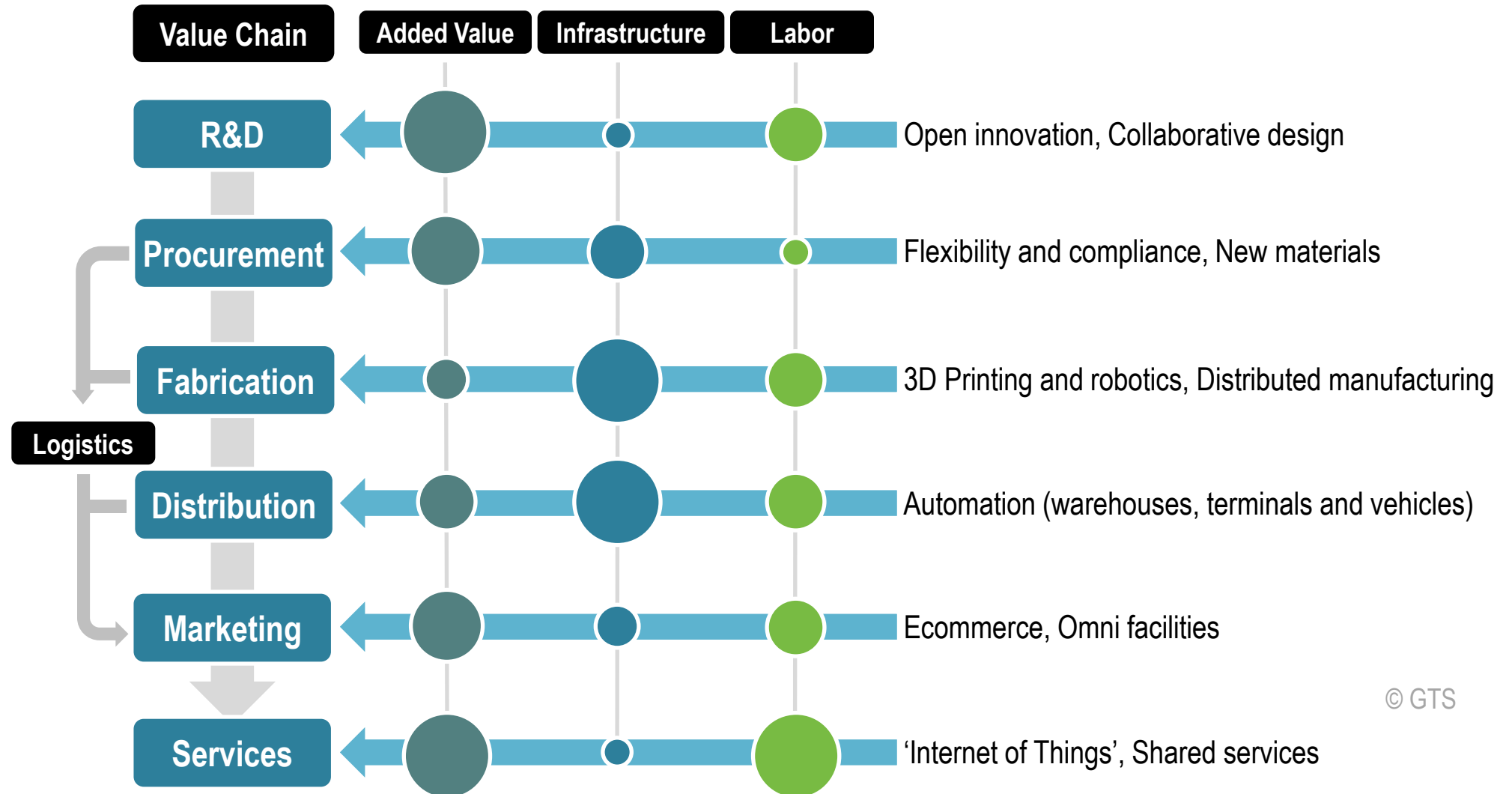
# Future Improvements in Maritime Transportation

Sector	Category	Measure
Ports	Operations	Ship loading/unloading optimization, Stacking optimization, Gate access
	Terminal design	Improved nautical profile, Yard design, Automation, Integration with inland transport systems (On-dock rail, barges)
	Alternative Fuels and Power	Electrification of gantry cranes and portainers, Alternative fuels (CNG) for yard equipment and drayage
Maritime Shipping	Operations	Speed reduction, Optimized routing, Reduced port time
	Ship Design and Propulsion	Novel hull coatings and propellers, Fuel efficiency optimization, Combined cycle operation, Multiple engines
	Alternative Fuels and Power	Marine diesel oil (MDO), Liquefied natural gas (LNG), Wind power sails

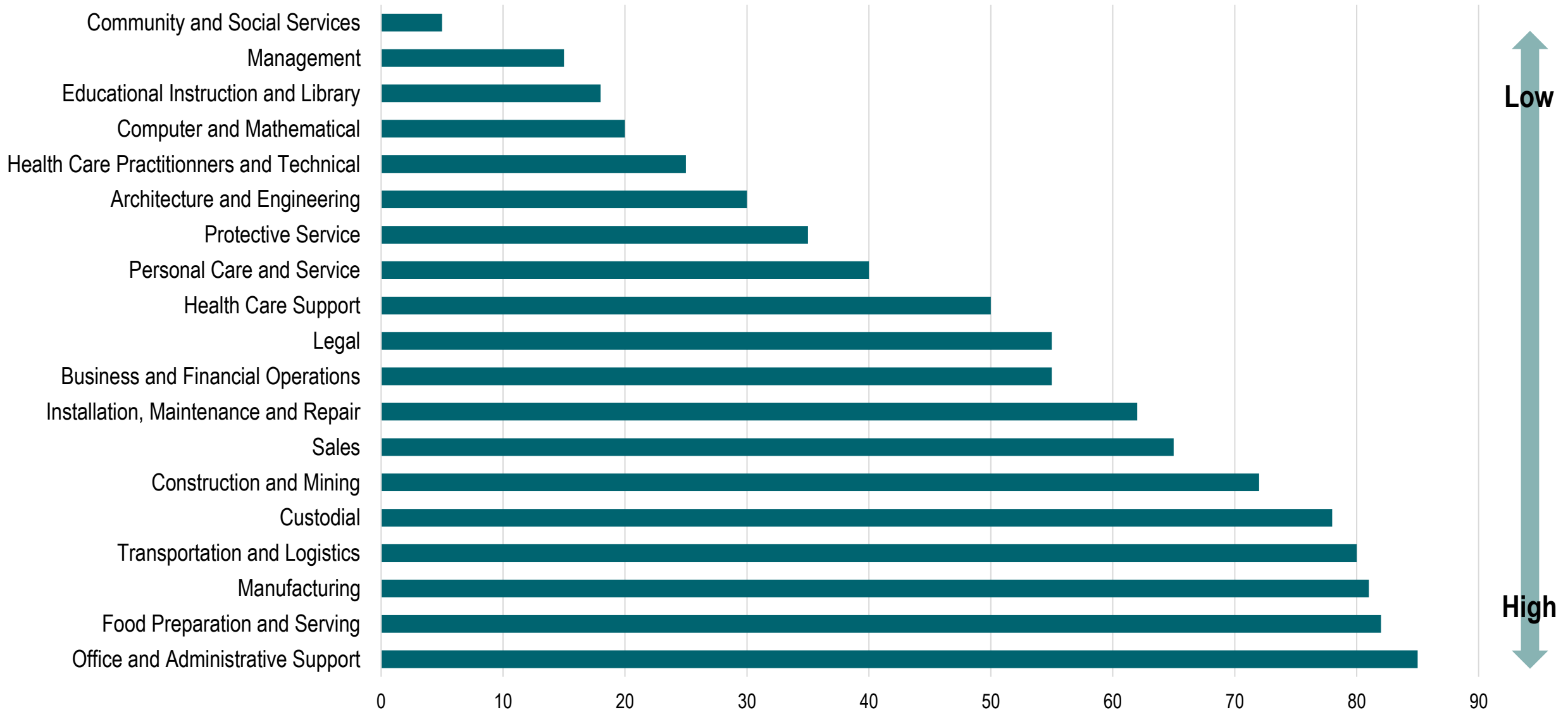
# The Four Industrial Revolutions



# Value Chain Drivers of the Fourth Industrial Revolution



# Probability of Automation by Occupation Group, United States, 2018-2030



# Phases of Development of the Global Economy

