Chapter 3:
Emerging Technologies

EMERGING TECHNOLOGIES

The rapid development and deployment of technology is affecting all parts of our lives, especially how we get around and how freight is moved. A variety of technologies are rapidly advancing and are already affecting the transportation industry and challenging transportation planners and policymakers in the Baltimore region.

Currently, technologies poised to have the greatest effects include:

1. Electrification of vehicles

- An electric vehicle (EV) is a vehicle that uses one or more electric motors for propulsion. Electricity is stored in an energy storage device, such as a battery.

- Widespread use can significantly improve air quality through reduced fossil fuel consumption and decreased emissions of greenhouse gases (GHGs) and other harmful air pollutants.

- This technology will provide benefits to personal vehicles, transit vehicles, and freight vehicles.

- Maryland has made significant progress in the past several years and expects to see registration of 60,000 EVs by 2020, approximately 300,000 EVs by 2025, and nearly 1.5 million EVs by 2040, with the infrastructure in place to accommodate those vehicles.

2. Shared Mobility / Mobility-as-a-Service (MaaS)

- MaaS is the integration of various forms of transport services into a single mobility service accessible on demand. Such services can offer a diverse menu of transport options such as public transport, ride sharing and car sharing/hailing, bike sharing, Escooters, taxi (land and water), or car rental/lease. These also can provide added value through use of a single application to afford access to mobility with a single payment channel instead of multiple ticketing and payment operations.

- A robust MaaS market (often called a "transportation ecosystem") should provide a range of safe and inexpensive alternatives to the use of the private car that may be as convenient as well as more sustainable, helping to reduce congestion and constraints in transportation capacity.

- Ridehailing and ridesharing options such as Transportation Network Companies (e.g., Lyft, Uber), car sharing (e.g., Zipcar), bike sharing (e.g. Lime, Spin) exist now in the region.

- Microtransit (e.g. the Annapolis Circulator, Chariot) is defined as a privately or publicly operated, technology-enabled transit service that typically uses multipassenger/pooled shuttles or vans to provide on-demand or fixed-schedule services with either dynamic or fixed routing.

- Cashless or electronic payment methods (e.g., E-ZPass, Moovel/ ReachNow) enable the use of MaaS, requiring users to have a credit card and often a smart phone. This could be a barrier for some travelers.
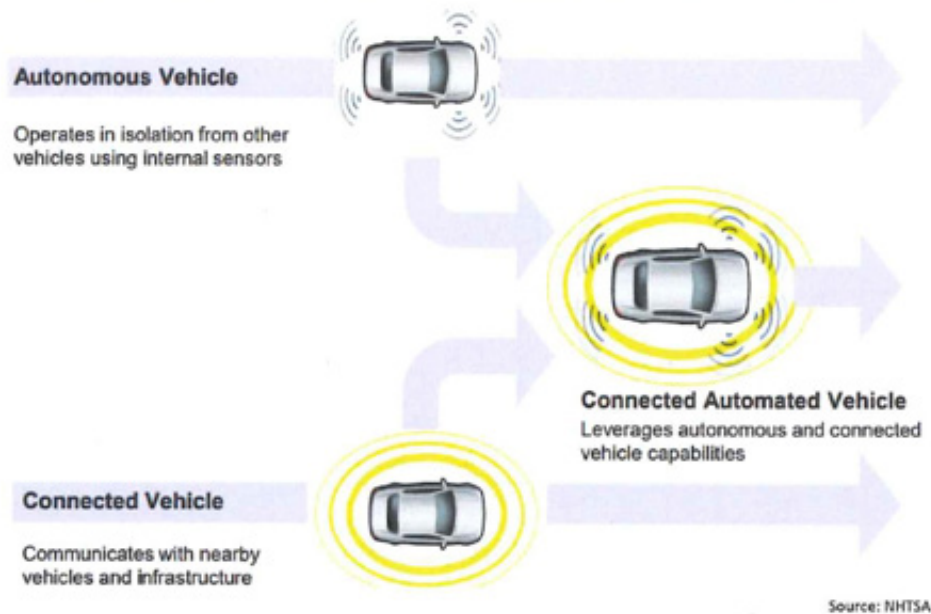
3. Big Data and Artificial Intelligence (AI)

- Improvements in manipulating, analyzing, and learning from very large and diverse data sets (Big Data), improvements to connectivity, and machine learning have enabled significant advancements in transportation services.

- Enhanced on-line communication (e.g., telecommuting, telemedicine, and e-commerce) is affecting travel demand and logistics for both passengers and freight.

- As more devices are connected to the Internet (the "Internet of Things" (IoT)), the ability to continuously send and receive data also will increase.

- "Smart" sensors enable remote monitoring and management of pavement and bridges, smart street lights, and other transportation infrastructure.

- Increases in data and connectivity have enabled new transportation service models and improved traveler and system operation information.

4. Autonomous Vehicle Technology

- Connected Vehicles (CVs): These have communications technology that enables them to share data with other vehicles and roadside infrastructure.

- Autonomous Vehicles (AVs): Technology most sought after because of the range of benefits it can offer. This technology uses sensors, cameras, and GPS to allow a vehicle to operate independent of a human operator. For discussion purposes, this includes both connected (vehicles that communicate between one another and/or a system) and unconnected autonomous vehicles.

- This technology will provide benefits to personal vehicles, transit vehicles, and freight vehicles. Freight transporters could reap significant benefits from truck platooning and automation as well as on-demand freight and delivery services.

Connected Automation for the Greatest Benefit

Autonomous Vehicle

Operates in isolation from other vehicles using internal sensors

Connected Automated Vehicle
Leverages autonomous and connected vehicle capabilities

Connected Vehicle

Communicates with nearby vehicles and infrastructure

Source: NHTSA

Increases in data and connectivity have enabled new transportation service models and improved traveler and system operation information.

5. 3D Printing / Improvements to Building Materials

- Changes in 3D printing and building material technology could have the most significant effects on the transportation network. 3D printing technology is expected to affect all aspects of transportation: planning, maintenance and operations, capital development and finance, and human resources and legal issues. Understanding the technology and its effect on the transportation network will be critical to making near-term and future business and capital decisions.

- 3D printing is a new, efficient manufacturing method that promises more freedom in design. This technology is being used to speed up repairs, cut manufacturing costs, improve quality control, and also reduce material waste while producing prototypes and multiple precise copies. With the ability to prototyp everything from vehicles to bridges and other transportation uses, 3D printing construction methods are using an ever widening variety of materials to allow many iterations at a lower cost, promising to improve product design.

- 3D printing technology is likely to pose many challenges to the way transportation agencies plan and conduct business. For example, time frames for decision making and planning horizons will shrink, affecting the viability of long-range planning and requiring transportation decision makers to become more responsive and decisive.

- This technology also likely will affect supply chain logistics,. For example, locally produced service parts could mean changes in manufacturing and construction distribution, with less of a need to import and/or export parts. Production and manufacturing could be vastly decentralized and customized, enabling small manufacturing hubs near end users and/or businesses to fill their own product needs. This could affect truck traffic patterns and the type of trucks needed. Such changes could ripple throughout the current transportation industry and disrupt it in ways we have yet to understand.

6. Unmanned Aerial Systems

- Unmanned aerial systems (UASs), sometimes called "drones," are aircraft outfitted with sensors such as cameras and LiDAR and controlled by a licensed operator on the ground.

- UASs can provide substantial benefits: increased safety, increased efficiency, and reduced costs.

- Transportation agencies are using UASs to perform activities related to structural inspection, construction inspection, geologic analysis, environmental analysis, and emergency response.

- MDOT and local jurisdictions already are using UASs for some of these activities. As a result of the benefits already realized, use of UASs is expected to continue to expand in the region.

7. Underground Tube Transport Systems

One intriguing emerging technology would use autonomous electric "skates" traveling underground through tubes at 125-150 miles per hour. Such a system could carry between 8 and 16 passengers, or a single passenger vehicle. One configuration of such a system would consist of a set of twin tunnels running in parallel. The ultimate objective is that this system would serve as the central artery for a potential future transportation network connecting metropolitan areas along the East Coast.

Another somewhat related technology is a proposed mode of passenger and/or freight transportation in a pressurized/sealed tube or system of tubes. This system would convey people or objects at high speed via pods traveling free of air resistance or friction. One version of this concept incorporates reduced-pressure tubes in which pressurized capsules ride on air bearings driven by linear induction motors and axial compressors. This system would propel passengers at speeds of up to 760 mph, considerably faster than conventional rail or air travel.

What Is the Industry's Vision of the Future?

Together these advancements are enabling new ways to move people and goods with on-demand mobility options and services. These offer the potential to improve dramatically the safety, reliability, accessibility, and environmental footprint of our transportation networks across modes. However, these technologies may also significantly affect travel demands and modes used by passengers and freight, land use patterns, and future transportation investment needs in ways that are not fully understood. Technology is as likely to improve performance as it is possibly to create unintended or adverse consequences.

Many of these technologies are in use to some degree today, but the level of use varies greatly. Many of us have used a Lyft or Uber service, a few of us may have a fully-electric vehicle or ridden in one, while some of us have vehicles with advanced technologies such as lane keeping or automatic braking. However, most of us have never been in a self-driving vehicle. Automation is central to how many new investors in transportation technology see the future transportation sector. This figure illustrates the interdependencies of vehicle technology, electrification, and sharing, as envisioned by industry:
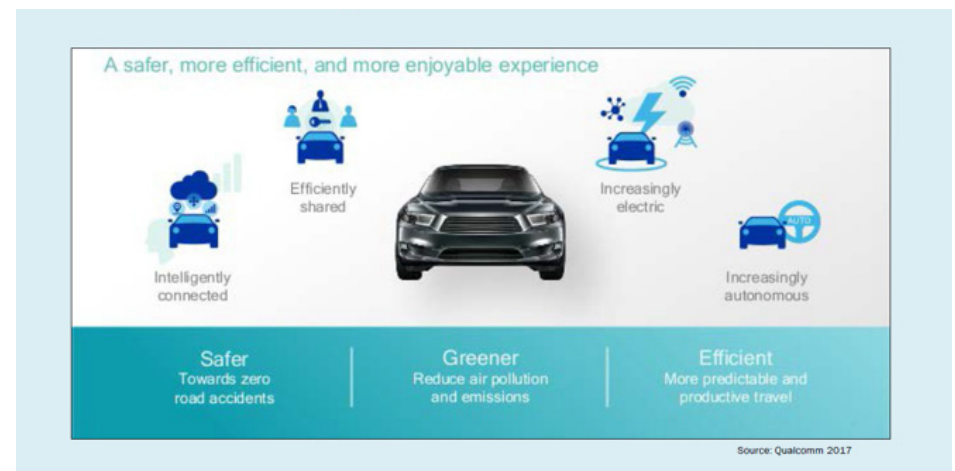

Source: Future Mobility Research Program, Metropolitan Transportation Commission, San Francisco Bay Area, October 2017. Accessed April 5, 2018.

https://mtc.ca.gov/sites/default/files/5a_Future%20Mobility%20Research%20Program%20%E2%80%93%20Update.pdf

While there are many announcements that companies will be introducing AV products into the market in the near term, there currently is no consensus on a schedule for significant penetration of autonomous or automated vehicles into the vehicle fleet. The figure below provides projections for sales, travel, and fleet that estimate it will be more than two decades until autonomous vehicles account for half of vehicle travel. It is clear from this graphic that through the planning period there will be significant changes, both challenges and opportunities, through the planning horizon.

Exhibit 13   Autonomous Vehicle Sales, Fleet and Travel Projections (Based on Table 6)
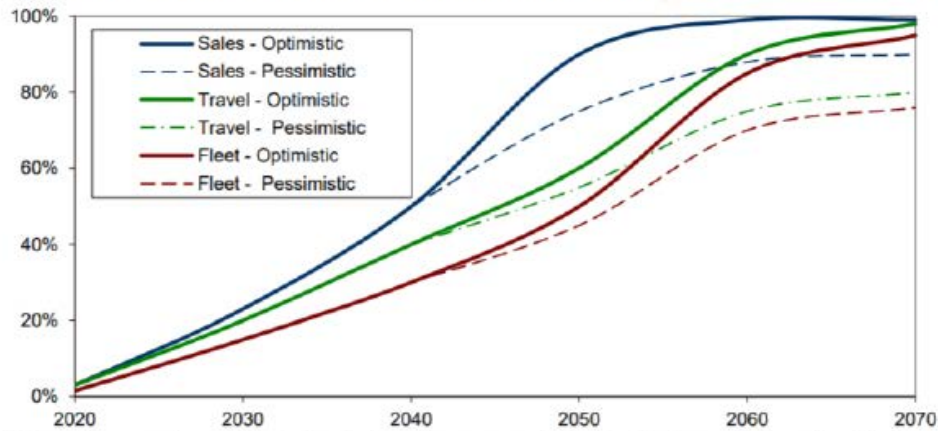
If they follow previous vehicle technologies autonomous vehicles it will take one to three decades to dominate vehicle sales, and one or two more decades to dominate vehicle travel, and even at saturation a significant portion of vehicle travel may continue to be human operated, indicated by the dashed lines.

Source: Victoria Transport Policy Institute, Autonomous Vehicle Implementation Predictions, March 23, 2018. Accessed April 5, 2018.
https://www.vtpi.org/avip.pdf
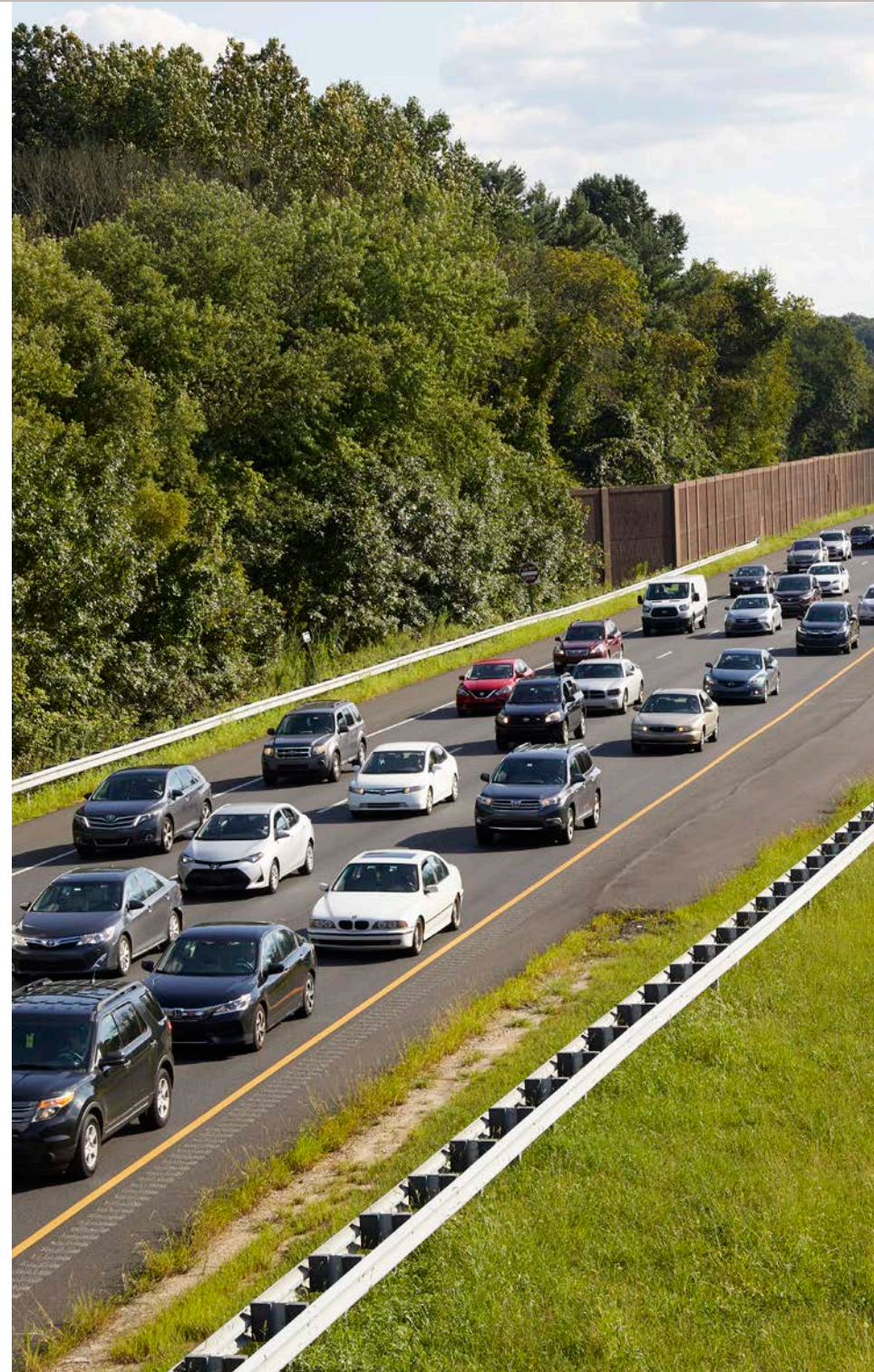
Uncertainties about the Effects of Emerging Technologies

As noted previously, there is significant uncertainty about the effects of emerging technologies, particularly CV/AVs: Will more congestion result from more vehicles on the road since automated vehicles will open opportunities for people who currently are not able to drive? Or will there be less congestion because vehicles can operate at peak efficiency? The following figure, from the Future Mobility Research Program, provides an overview of potential effects of automated vehicles:

Source: Future Mobility Research Program

Another slide from the same study shows impact ranges for some key variables.

Literature Review Ranges for Key Variables

Timing	**3 to 13** years until fully driverless vehicles available for purchase
Safety	**+40% to +90%** increase in safety
Capacity	**0% to +45%** increase in roadway capacity
Demand	**+5% to +40%** increase in vehicle miles traveled (VMT)
Energy/Emissions	**-50% to + 100%** change in greenhouse gas (GHGs) emissions

Source: Future Mobility Research Program

Emerging Technologies – Maryland-Specific Activities

Maryland DOT has taken on a leadership role on CV/AV deployment. The Maryland C/AV Working Group, which is chaired by the Administrator of the Motor Vehicle Administration, meets several times a year and includes a wide array of public and private sector stakeholders, including MPOs. The MDOT Transportation Business Units (TBUs) are also working individually on their own CV/AV planning.

Maryland DOT and its TBUs have undertaken several CV/AV pilot projects, and MDOT has created a process for companies to register to test AVs in Maryland. The BRTB will track the status of the pilots, as data is available. In addition, BRTB and staff will continue to work closely with MDOT and its TBUs to support the deployment of emerging technologies.

Emerging Technologies – Role of the BRTB

As part of the development of this plan, the Technical Committee that advises the BRTB looked at potential new strategies to help the region achieve some of the region's transportation goals. In this capacity, the Technical Committee recommended some additional language to address emerging technologies. In addition, the BRTB's Public Advisory Committee, consisting of members of the public and stakeholder groups, commented on this recommended language.

New Implementation Strategies

Based on these recommended additions and comments, the BRTB adopted several new implementation strategies in support of the regional goal to Promote Informed Decision Making. As noted, the BRTB adopted these strategies with review and input by its Technical Committee and its Public Advisory Committee.

New strategies related to emerging technologies:

- Plan for the effects of emerging technologies and increasing vehicle/infrastructure connectivity when moving projects through the project development process. For example, consider the long-term effects of, and infrastructure needs related to, connected and automated vehicle use on traveler safety, roadway congestion, and land use when planning for new and improved transportation facilities. Make project scopes more flexible as needed to accommodate the potential effects of such emerging technologies.

- Plan for the effects of alternative means of travel (e.g., ride hailing services, micro-transit services, ridesharing, etc.) on traveler safety and security, roadway congestion, and land use.

- Improve information systems (e.g., signage, bus service information, smartphone applications) that all travelers can use to reach destinations easily and safely.

Continued Monitoring

As use of these emerging technologies becomes more widespread, the BRTB will continue to monitor potential risks and impacts and identify actions to take. Understanding the potential and consequences of technologies is important to help to ensure the region harnesses the positive effects of technology and avoids or minimizes potential negative effects.

Specific actions of the BRTB will include:

- Tracking technology development and deployment within the region, nationally and internationally to understand and plan to take full advantage of the technology benefits and minimize disadvantages from new and emerging technologies

- Investigating how to use newly available data to enhance transportation planning

- Working with stakeholders, especially elected officials and the public, to manage expectations and perceptions, minimize future problems, and leverage opportunities

- Building technical, institutional, and policy capacity, and including new partners as necessary

- Working to monitor deployment throughout the region to ensure equitable distribution of the benefits technology can offer
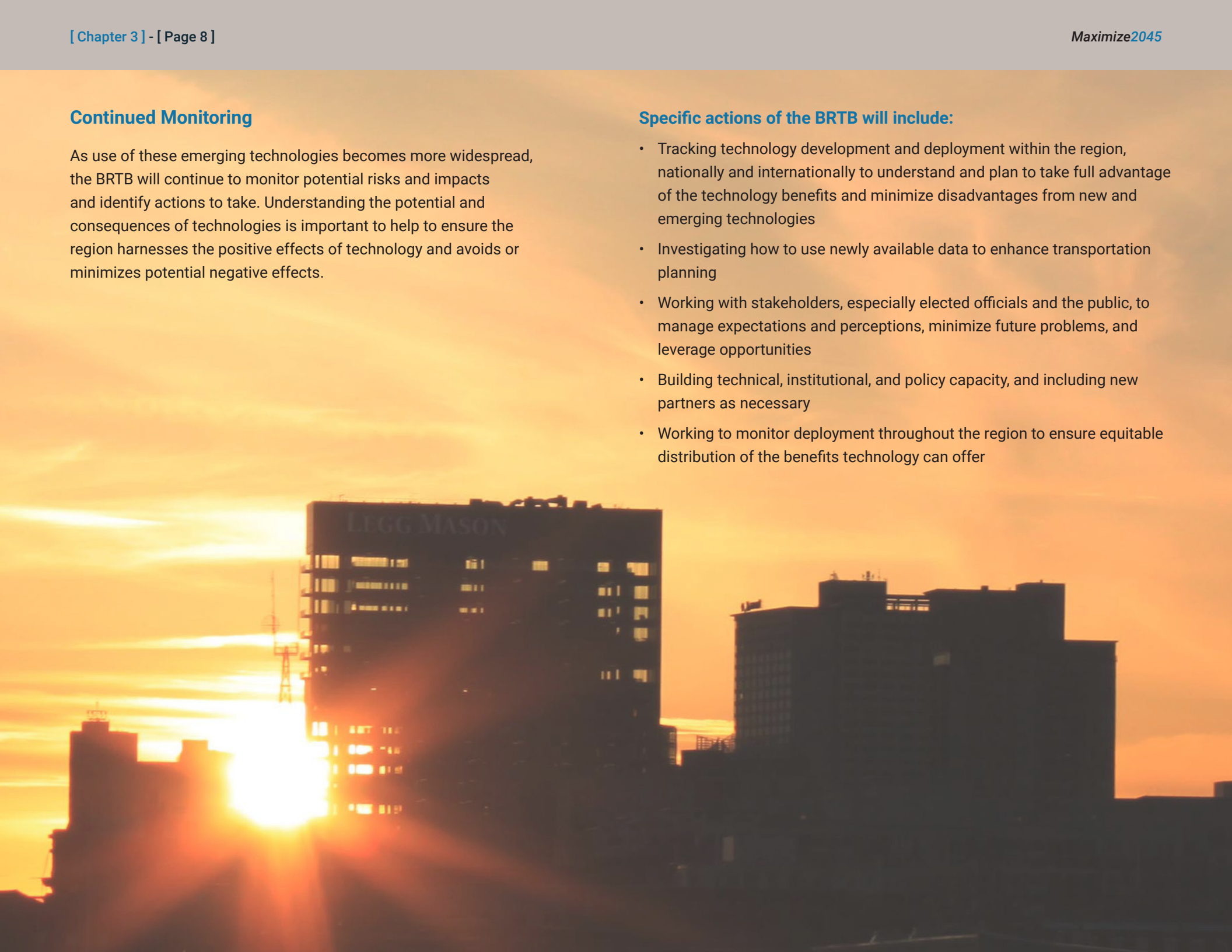
The region is in the early stages of implementing these emerging technologies, with rapid advances being discussed or occurring seemingly every day. However, the BRTB's mission and goals remain constant, and the region will continue to make investment decisions and develop programs and projects that support a safe, efficient, accessible, equitable, and environmentally responsible transportation system for all users.