De-center / Expand Access: Drone public transit in low density areas

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Keywords: urban design, infrastructure, transit, equity.

SUMMARY

Social justice can be pursued through expanding accessible and affordable public transit in low density urbanisms. This paper outlines the future viability of a drone-based local transit system for America's medium-sized cities, connecting residents of low-density neighborhoods to educational and job opportunities in suburban locations.

CHALLENGES FOR TRANSIT IN MEDIUM-SIZED CITIES

Most Americans are in medium sized cities, with a mix of urban and suburban spatial typologies. In their low-density areas, local governments have struggled to fund viable transit systems, inevitably relying on bus routes. Buses typically do not require expensive infrastructure and offer flexibility in changing routes. Nevertheless, bus systems suffer from the compounding inefficiencies of long waits, traffic congestion, and poor ridership.

As a result, poorly funded local bus transit programs are unable to effectively connect working class neighborhoods to dispersed suburban locations with numerous job and educational opportunities. This reliance on inefficient bus transit or automobile ownership contributes to social injustice in low density areas.

The United States needs a more robust urban imagination regarding transit, especially in these low density areas. A drone-based public transit system retains the flexible advantages of a bus system, utilizing existing air space over road routes, while avoiding the bus system's disadvantages and low ridership.

DRONE CAPACITIES IN PUBLIC TRANSIT

A drone-based local transit system has many advantages over the ubiquitous bus system. In the next few decades, drone capacities will expand beyond small payloads for short distances. Integrating drones into public transit systems offers

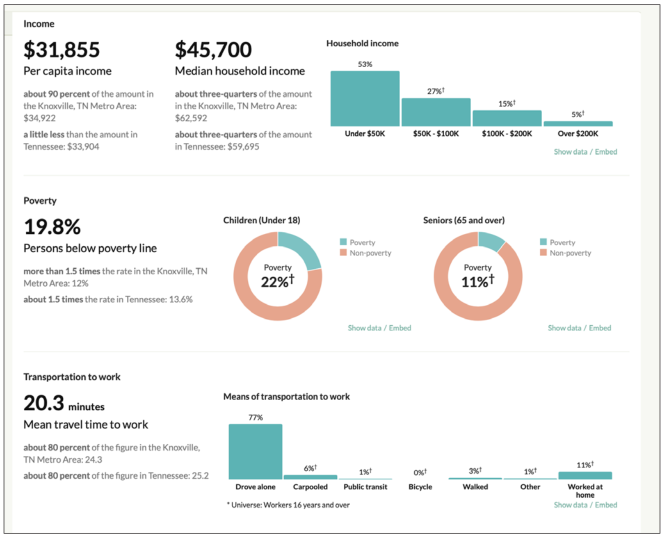

Figure 1. Knoxville demographics. Census Reporter.org, 2022.

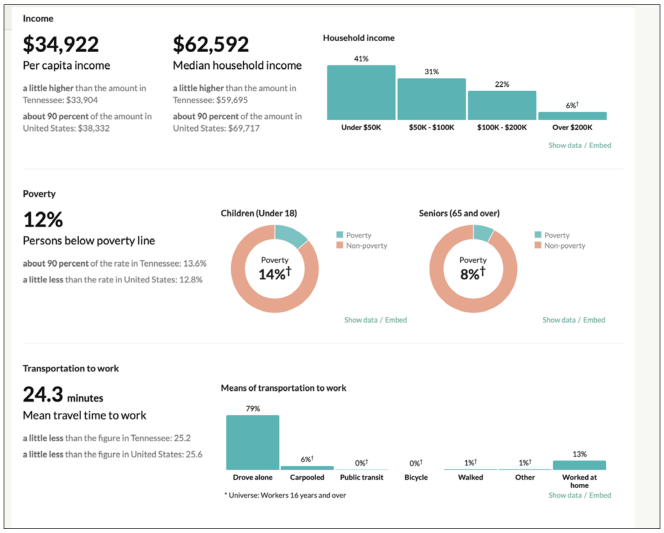

Figure 2. Metro area demographics. Census Reporter.org, 2022.

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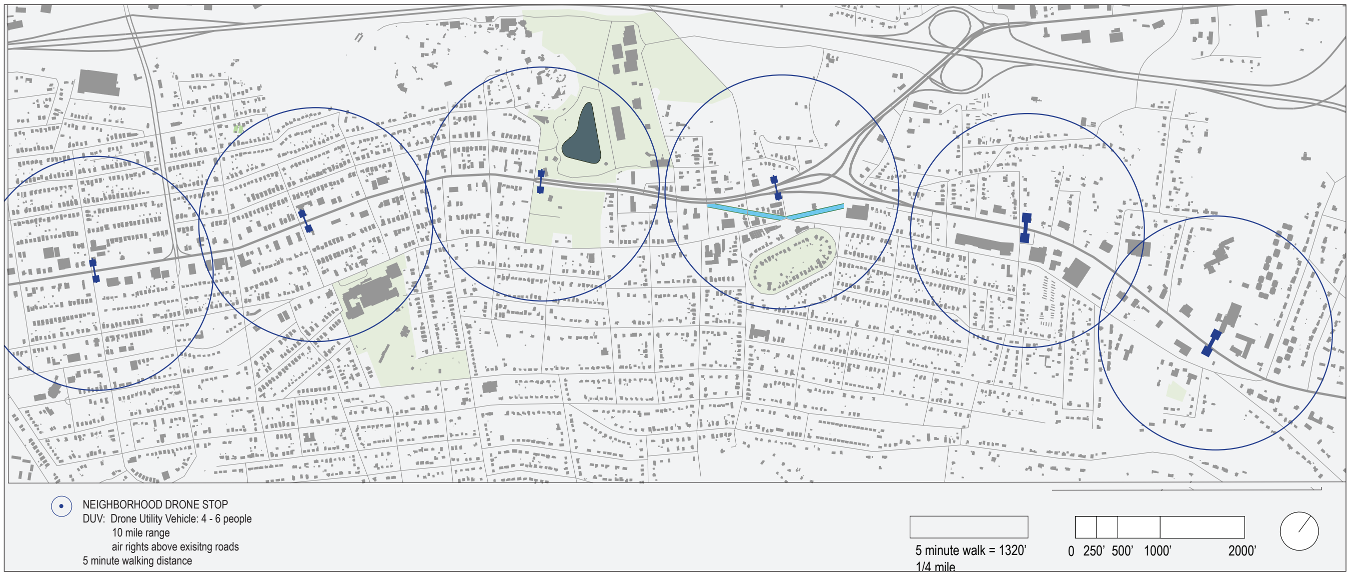


Figure 3. Neighborhood Drone Stops in East Knoxville: author's illustration. Each circle represents a five-minute walk radius to the drone stop. Depending on demand, additional drone stops can be added for short neighborhood routes.

many advantages for creating a more nimble transit system, thus expanding access to transit, housing, jobs, and education.

Drones elevate vertically to directional routes at designated elevations well above utility lines and trees. These routes follow the air-space above existing major roads, while avoiding the traffic congestion at road level, resulting in faster travel times, which in turn increases ridership. By taking advantage of existing road air space , drone transit will not require extensive new infrastructure. Drone passenger vehicles, for 4-8, are much smaller than the typical 20–50 person buses, thus reducing wait-times, creating more efficient routes, and increasing ridership. Driverless / autonomous drones have fewer risks than autonomous road vehicles, which have difficulty anticipating errant pedestrians crossing streets. The small size of drone passenger vehicles allows them to reach low density neighborhoods, thus extending the viability of public transit within medium-sized cities.

DEMONSTRATION PROJECT FOR KNOXVILLE

As a demonstration, I have developed a scalable drone transit system for Knoxville, a medium sized city of 187,000 in a larger metropolitan area of 870,000. Its hilly topography, near the foothills of the Smoky Mountains, has resulted in irregular growth patterns based on curving roads emanating from the city center. While the city has a compact, vibrant Downtown, most employers, schools and commercial districts are in more de-centralized suburban locations throughout the metropolitan area and adjacent counties. Knoxville has limited funding for transit.

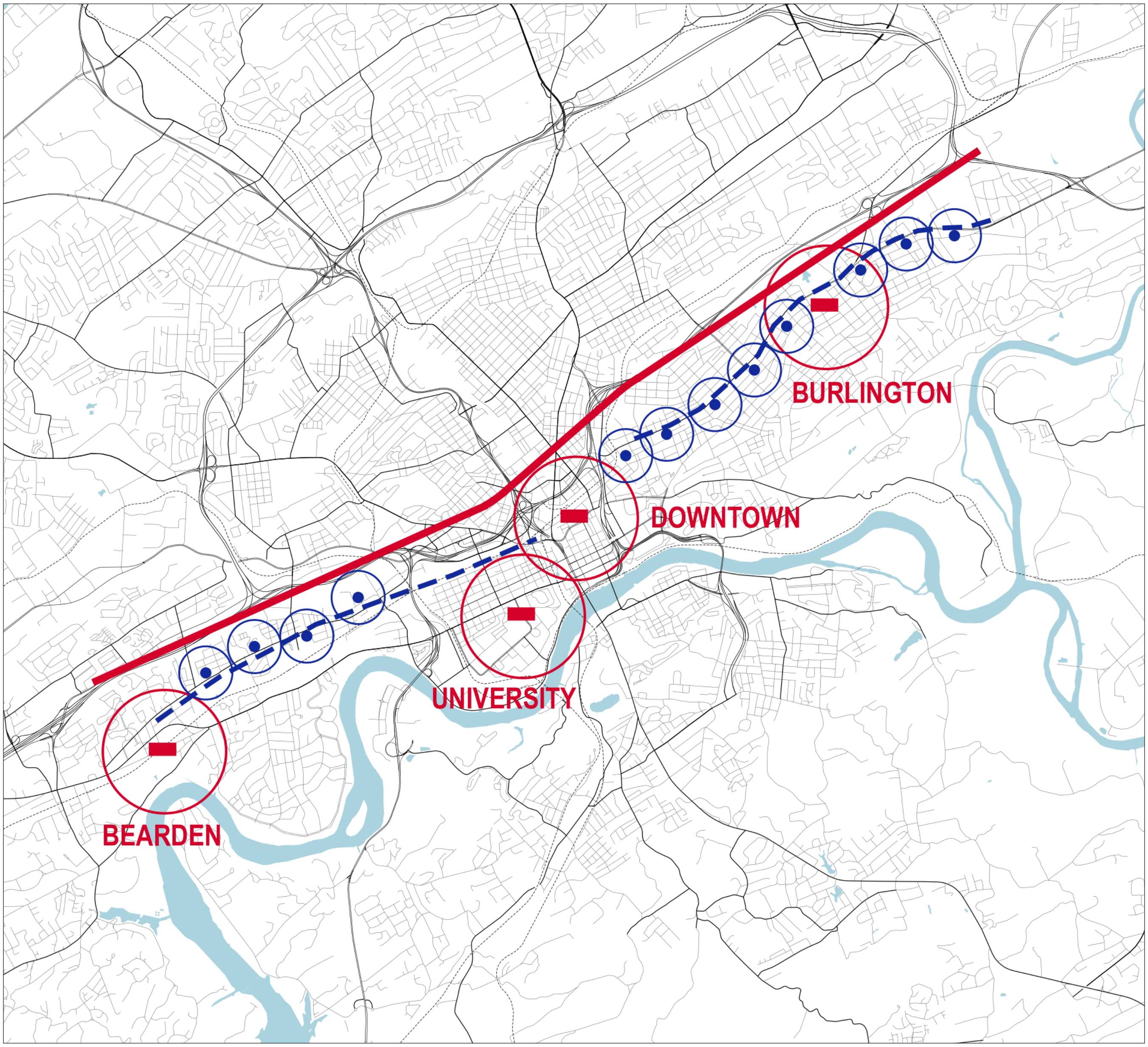
Approximately 79% of residents in the metro area commute by car to work, with an average commute time of 24 minutes. 1% of city and metro residents report using public transit for commuting .

The city has a well-managed bus system, with 23 routes and 1100 bus stops which are within ¼ mile of 80,000 residents. Nevertheless, the bus system is characterized by long waits and poor ridership numbers. Because of the topography, a rail transit system, an elevated infrastructure, or even upgrades for bus-rapid-transit lanes, would not be feasible.

SCALABLE, FLEXIBLE, AND INCREMENTAL

A small "DUV" Drone Utility Vehicle carries about 4-8 passengers and has a small battery pack for short distances, under 10 miles. A larger "DBV" Drone Bus Vehicle could carry 25-50, with longer travel capacities, depending on battery configuration. These larger DBV's would interconnect popular destination points.

An initial route is proposed along a commercial spine flanked by low density urban neighborhoods, with single family homes. This route includes a number of stops, within walking distance of many residents. "Neighborhood Drone Stops" for the DUVs are elevated platforms, connecting two sides of the commercial street corridor, ideally with a charging station. At take-off, the



NEIGHBORHOOD DRONE STOP
DUV: Drone Utility Vehicle: 4 - 8 people
10 mile range
air rights above exisitng roads
HCP High Capacity Parking Grid

DISTRICT / CENTER / TRANSIT STATION
DBV: Drone Bus Vehicle: 25 - 50 people
15 mile range
air rights above exisitng highways
HCP High Capacity Parking Grid
Transfer station for DUVs, DBVs, and bus

NEIGHBORHOOD DRONE ROUTES
Above existing commercial corridor
East / west traffic is segregated at elevation levels

HCP High Capacity Parking Grid v

Figure 4. Phase One for drone-based public transit for Knoxville, linking two urban neighborhoods along a commercial corridor with four major destinations in the city: author’s illustration.

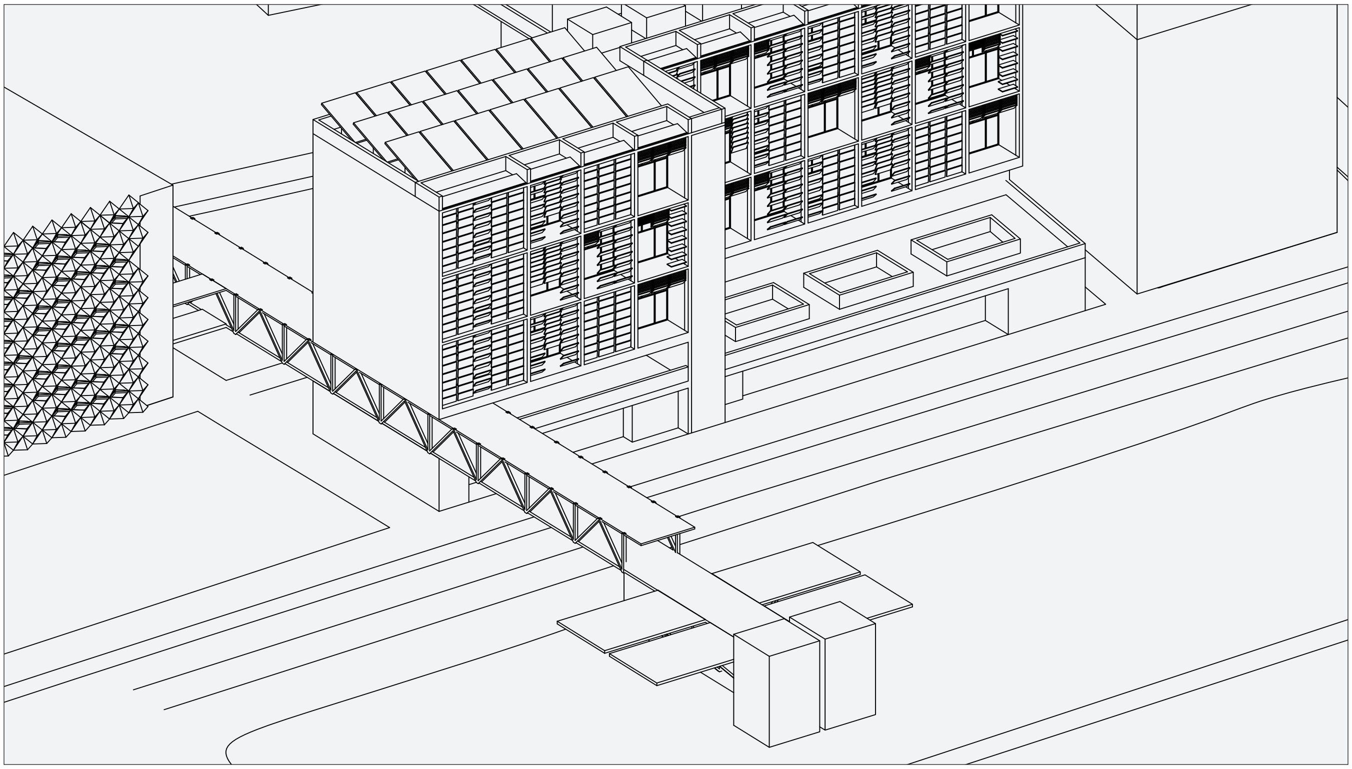


Figure 5. Neighborhood Drone Stops: student work by Harry Tarter, 2019, supplied by author. The typical neighborhood transit stop is elevated above the sidewalk level of a major commercial street, with an elevator and pedestrian bridge. Drone Utility Vehicles arrive and depart vertically.

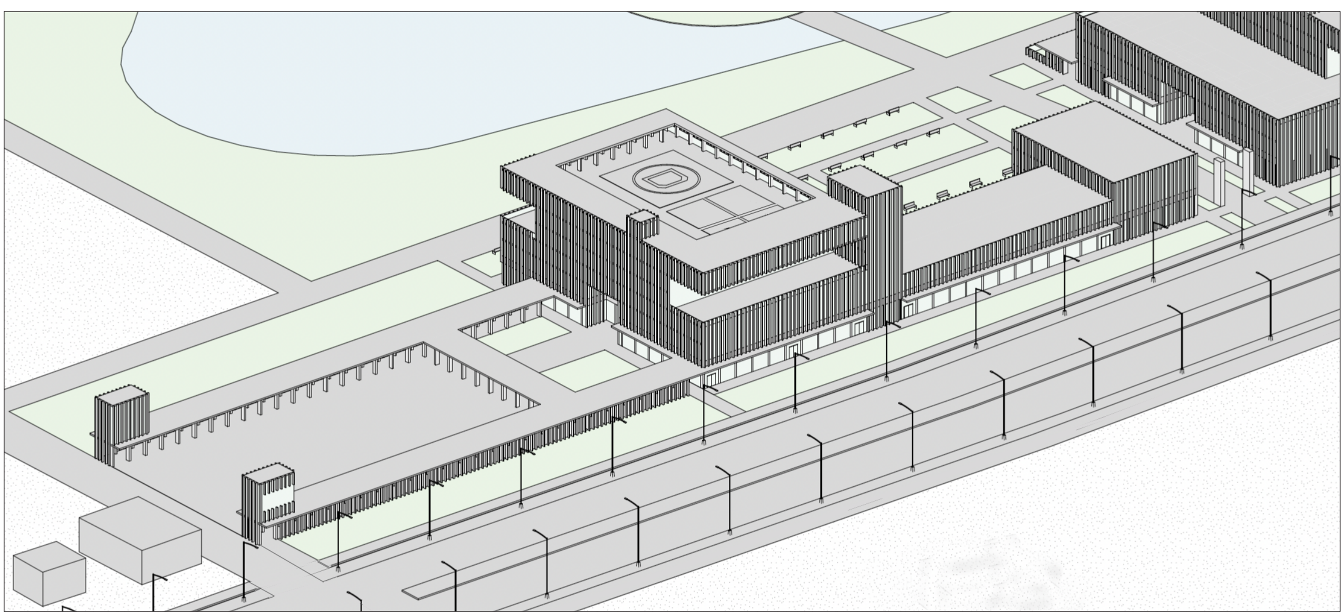


Figure 6. District Transit Station: student work by Thomas Miller, 2022, supplied by author. Passengers transfer among smaller Drone Utility Vehicles, and larger Drone Bus Vehicles, allowing connections to other district destinations. This proposed station, in Burlington East Knoxville, is located at a public park, the city zoo, and the future location of the minor hockey team arena. It is also within walking distance to the Burlington downtown commercial area, the local high school, and a residential area of single family homes. High density parking and transfer to bus routes are also part of this District Transit Station.

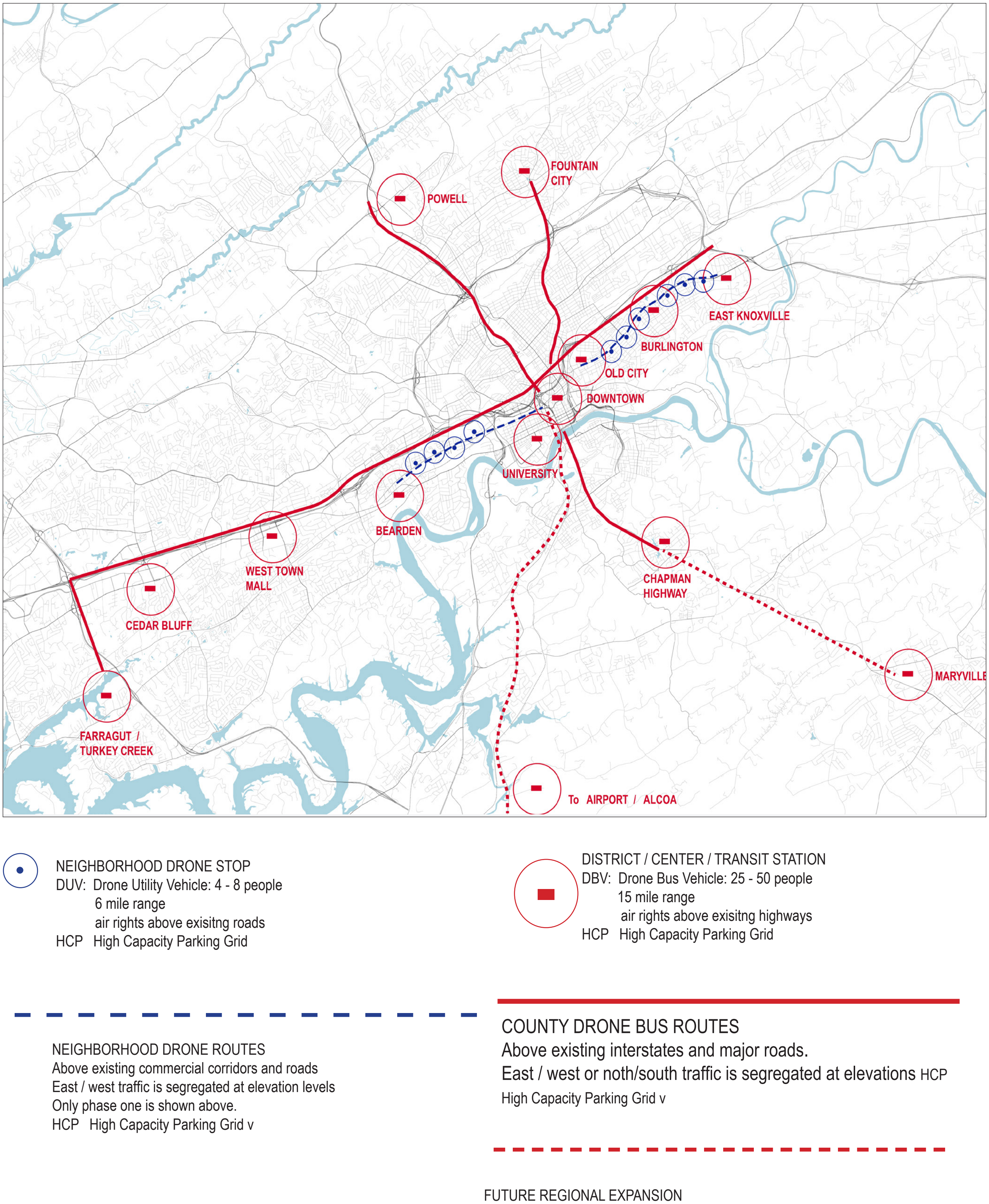


Figure 7. Phase Two for drone-based public transit for Knoxville: Regional network, linking low density neighborhoods to regional destinations: author's illustration.

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DUV elevates to the designated airspace above the linear commercial corridor. New infrastructure construction is limited to the neighborhood drone stops and battery charging stations.

Routes can be configured in many different ways, with a traditional set schedule or utilizing dynamic scheduling with an on-call app for users. This flexible scheduling of the drone transit system is easily responsive to changing usage patterns.

INCREMENTAL EXPANSION OF NEIGHBORHOOD ROUTES AND DISTRICT TRANSIT CENTERS

Expansion of routes is incremental and flexible, creating a more agile and responsive transit system. This gives municipalities more leeway in planning and funding their transit needs over time. Additional routes could be planned along similar commercial corridors, near low density residential neighborhoods.

A destination “District Transit Center” is proposed for popular areas, such as the Downtown, the campus, malls, large schools, the airport, and significant suburban job locations. The District Transit Center accommodates more passengers, transferring to other DUVs or to a larger 50 passenger “Drone Bus Vehicles” (DBV) which in turn connects to other popular destinations. These District Transit Centers would be something of a transit hub, interconnecting small DUVs, larger DBVs, buses, and high density parking solutions.

REGULATORY CONCERNS

As innovative air mobility research creates new possibilities, the regulatory environment will define safe travel elevations and routes for increasingly diverse types of airborne vehicles. While this hypothetical proposal for Knoxville outlines linear routes in designated air space above existing major roads, future routing systems can be more dynamic and complex. Safety concerns for autonomous drivers is also new regulatory terrain. The development of new regulations and policies should anticipate diverse uses, including local public transit.

MUNICIPAL FUNDING

Because drone transit relies on the air space above existing road corridors, it requires minimal new construction and infrastructure investment. The small scale DUV’s are relatively affordable, as are the elevated transit stops. As the system expands incrementally, the funding can expand incrementally as well. These autonomous vehicles do not require the expense of drivers.

REGIONAL AND RURAL EXPANSION

As drone transit within Knox County develops, the system can expand regionally to adjacent counties and rural destinations. Incremental growth is determined by the technological capacity of the drone size and battery capacity. Isolated, low-density rural areas can benefit from the cost-efficient, small, flexible, and incremental infrastructure planning of a drone-based transit system.

In 2018, the State Commissioner of Economic and Community Development ran for Governor. In his campaign, he outlined ideas he had pursued for creating a series of job training facilities at regional, rural high schools. As Commissioner, he met with regional employers who would eagerly fund this type of job training, and most rural high schools had space for expanded facilities. He discovered that the sole impediment to this concept was the lack of affordable transportation in rural areas.(2)

SUMMARY

This drone public transit concept offers an affordable way for local municipalities to provide transit in low density areas, thus enhancing social equity through expanding access to jobs and educational opportunities.

ENDNOTES

1. The concept for a form of local drone travel emerged from a design studio, speculating about transit along a local commercial street, Sutherland Avenue. We worked in collaboration with the East Tennessee Community Design Center, a non profit organization affiliated with the local AIA and City of Knoxville government.
2. Randy Boyd, President, University of Tennessee and former State Commissioner of Economic and Development. Business entrepreneur and owner, Knoxville Smokies. He has a high profile throughout the state.
3. During the development of this concept, a number of national experts were consulted: John Foote, Research Fellow, Taubman Center for State and Local Government, Kennedy School of Government, Harvard University ; Tom Fisher, Director of the Minnesota Design Center, Professor, and Former Dean, University of Minnesota; Shivika Sahdev, Partner, McKinsey & Co.: auto, air innovation, for private equity investors.
4. David Goedicke, Carmel Zolkov, Natalie Friedman, Talia Wise, Avi Parush, and Wendy Ju, "Strangers in a Strange Land: New Experimental System for Understanding Driving Culture using VR," in IEEE Transactions on Vehicular Technology 71:4 (2022):
5. Robin Riedel, et al, "To take off, flying vehicles first need places to land", McKinsey Report, August 31, 2020
6. Benedikt Kloss ,Robin Riedel, "Up in the air: How do consumers view advanced air mobility?" McKinsey Report, June 1, 2021
7. Robin Riedel et al, "Future Air Mobility Blog"—established July 3, 2021, McKinsey Consulting
8. Cade Metz and Erin Griffith, "Flying Car Makers Want to Build 'Uber Meets Tesla in the Air' " New York Times, June 12, 2021
9. Adrienne Bernhard, "The flying car is here-and it could change the world" BBC Future Inc | Transport, November 2020
10. Ariel H. Bierbaum, Alex Karner & Jesus M. Barajas (2021) Toward Mobility Justice, Journal of the American Planning Association, 87:2, 197-210, DOI: 10.1080/01944363.2020.1803104
11. David Zipper, "When Cities Say No to New Transportation Technology" Bloomberg.com, May 19, 2021
12. Benedikt Kloss ,Robin Riedel, "Up in the air: How do consumers view advanced air mobility?" McKinsey Report, June 1, 2021
13. Robin Riedel, et al, "To take off, flying vehicles first need places to land", McKinsey Report, August 31, 2020
14. Robin Kellermann, Tobias Biehle, Lilian Fischer, "Drones for parcel and passenger transportation: A literary review," Transportation Research Interdisciplinary Perspectives, 4, 2020[1]

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