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A NEXA Capital Company

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Urban Air Mobility Business and Market Forecasting

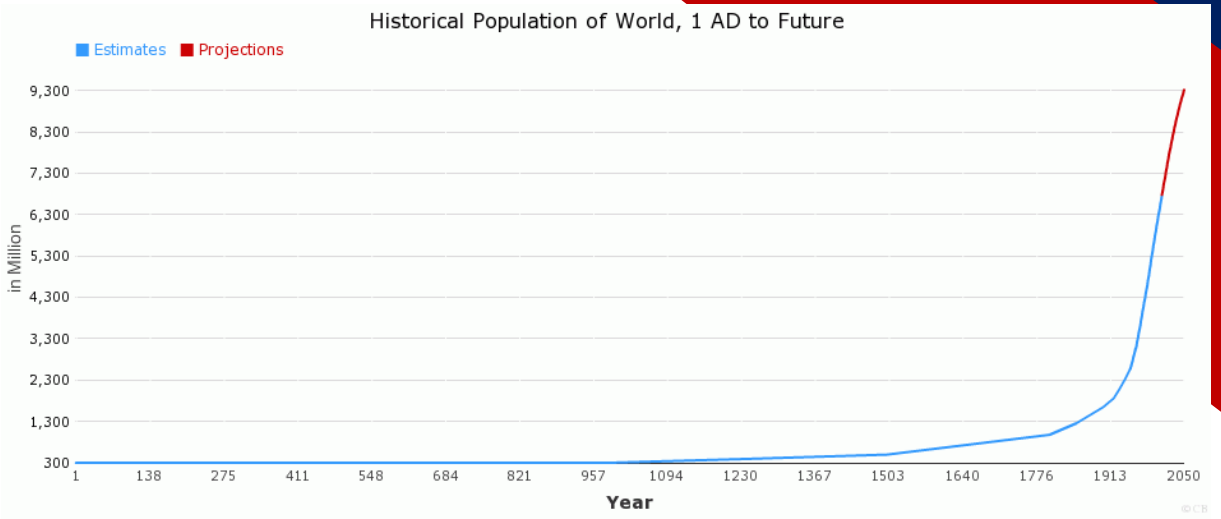
Geo-Coding the Future of Urban Air Mobility

July 27, 2021
Presentation to: North Central Texas Council of Governments

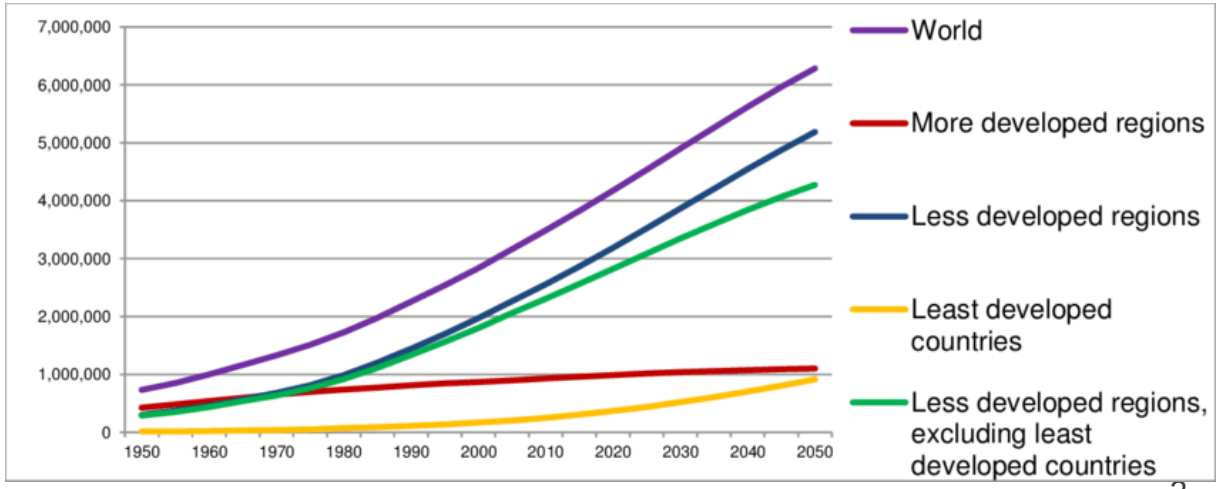
What is Driving Urban Air Mobility

- According to the United Nations, the urban population of the world has grown rapidly from 751 million in 1950 to 4.2 billion in 2018.
- By 2050 over 6 billion people may be living in urban areas.
- **Congestion:** Mobility of people, delivery of goods and services, quality of life suffer.
- Urban air mobility has potential to use airspace above cities to restore mobility and decongest city streets.
- Advancement of aerospace technologies, composite materials, batteries, motors and automation systems now make this possible.

World Population Growth to 2050

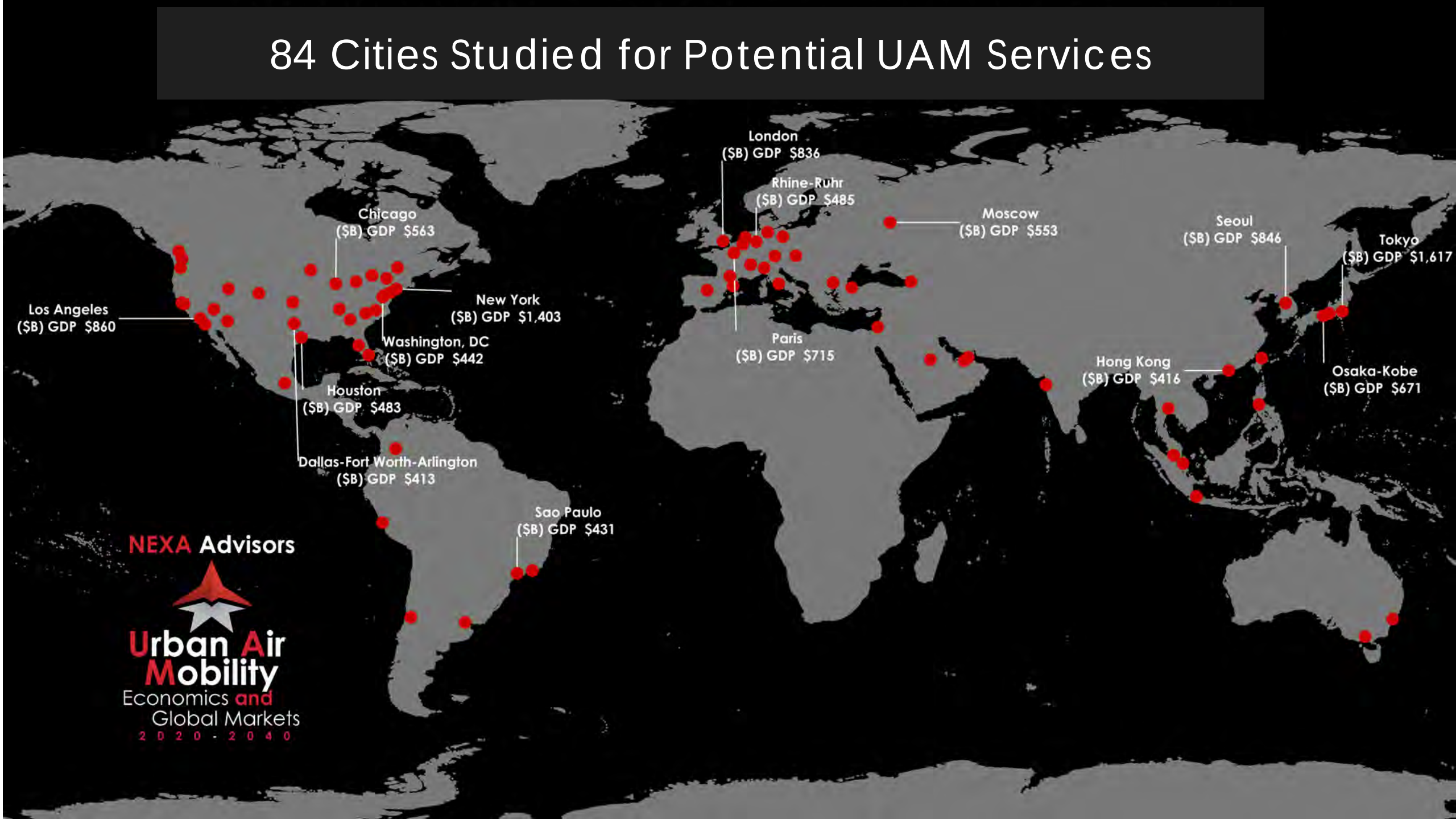


Urbanization Forecast to 2050



Many and Varied Concepts of Urban Operations

84 Cities Studied for Potential UAM Services



We Analyzed 84 Greater Metro Areas

- The metro areas analyzed in this body of research are listed, ranked by GDP in the millions of U.S. dollars.
- Purchasing power parity (PPP) is a method of measuring economic variables in different countries so that irrelevant exchange rate variations do not distort comparisons.
- Note that these cities comprise some 25% of global GDP.
- 37 metro areas are in the U.S.

Rank	City	(B) GDP in MM PPP	Rank	City	(B) GDP in MM PPP
1	Tokyo	$ 1,616,792	43	Melbourne	$ 178,392
2	New York	$ 1,403,463	44	Abu Dhabi	$ 178,256
3	Los Angeles	$ 860,452	45	Rio de Janeiro	$ 176,630
4	Seoul	$ 845,906	46	Lima	$ 176,447
5	London	$ 835,658	47	Baltimore	$ 173,747
6	Paris	$ 715,080	48	Kuala Lumpur	$ 171,772
7	Osaka-Kobe	$ 671,295	49	Santiago	$ 171,436
8	Chicago	$ 563,188	50	Barcelona	$ 171,032
9	Moscow	$ 553,318	51	Denver	$ 169,737
10	Rhine-Ruhr	$ 485,218	52	Riyadh	$ 163,476
11	Houston	$ 483,184	53	Rome	$ 163,243
12	Washington, DC	$ 442,212	54	Hamburg	$ 161,437
13	Sao Paulo	$ 430,510	55	San Jose	$ 160,339
14	Hong Kong	$ 416,047	56	Bogota	$ 159,850
15	Dallas-Fort Worth	$ 412,674	57	Portland	$ 158,544
16	Mexico City	$ 403,561	58	Berlin	$ 157,706
17	Singapore	$ 365,928	59	Montreal	$ 155,905
18	Nagoya	$ 363,751	60	Cincinnati-Northern KY	$ 153,900
19	Boston	$ 360,110	61	Tel Aviv	$ 153,297
20	Istanbul	$ 348,721	62	Mumbai	$ 150,853
21	Philadelphia	$ 346,455	63	Orlando	$ 147,200
22	San Francisco	$ 331,024	64	Charlotte	$ 140,923
23	Taipei	$ 327,295	65	Columbus	$ 130,800
24	Jakarta	$ 321,315	66	Tampa	$ 130,314
25	Amsterdam	$ 320,600	67	Cleveland-Elirya	$ 119,300
26	Buenos Aires	$ 315,885	68	Vancouver	$ 109,805
27	Milan	$ 312,108	69	Norfolk-Newport News	$ 103,100
28	Bangkok	$ 306,765	70	Nashville	$ 94,968
29	Atlanta	$ 294,420	71	Las Vegas	$ 93,858
30	Toronto	$ 276,313	72	New Orleans	$ 83,600
31	Seattle	$ 267,473	73	Dubai	$ 82,867
32	Miami	$ 262,697	74	Salt Lake City	$ 73,836
33	Madrid	$ 262,335	75	Raleigh-Durham-Chapel Hi	$ 69,302
34	Brussels	$ 254,327	76	Toulouse	$ 47,384
35	Sydney	$ 223,413	77	Geneva	$ 43,980
36	Munich	$ 219,943	78	Dayton	$ 41,100
37	Minneapolis-St. Paul	$ 211,398	79	Syracuse	$ 40,576
38	Detroit	$ 207,538	80	Toledo	$ 34,900
39	Phoenix	$ 207,065	81	Wichita	$ 33,840
40	San Diego	$ 202,490	82	Akron	$ 33,100
41	Vienna	$ 183,712	83	Huntsville	$ 29,500
42	Manila	$ 182,842	84	Plovdiv	$ 10,995

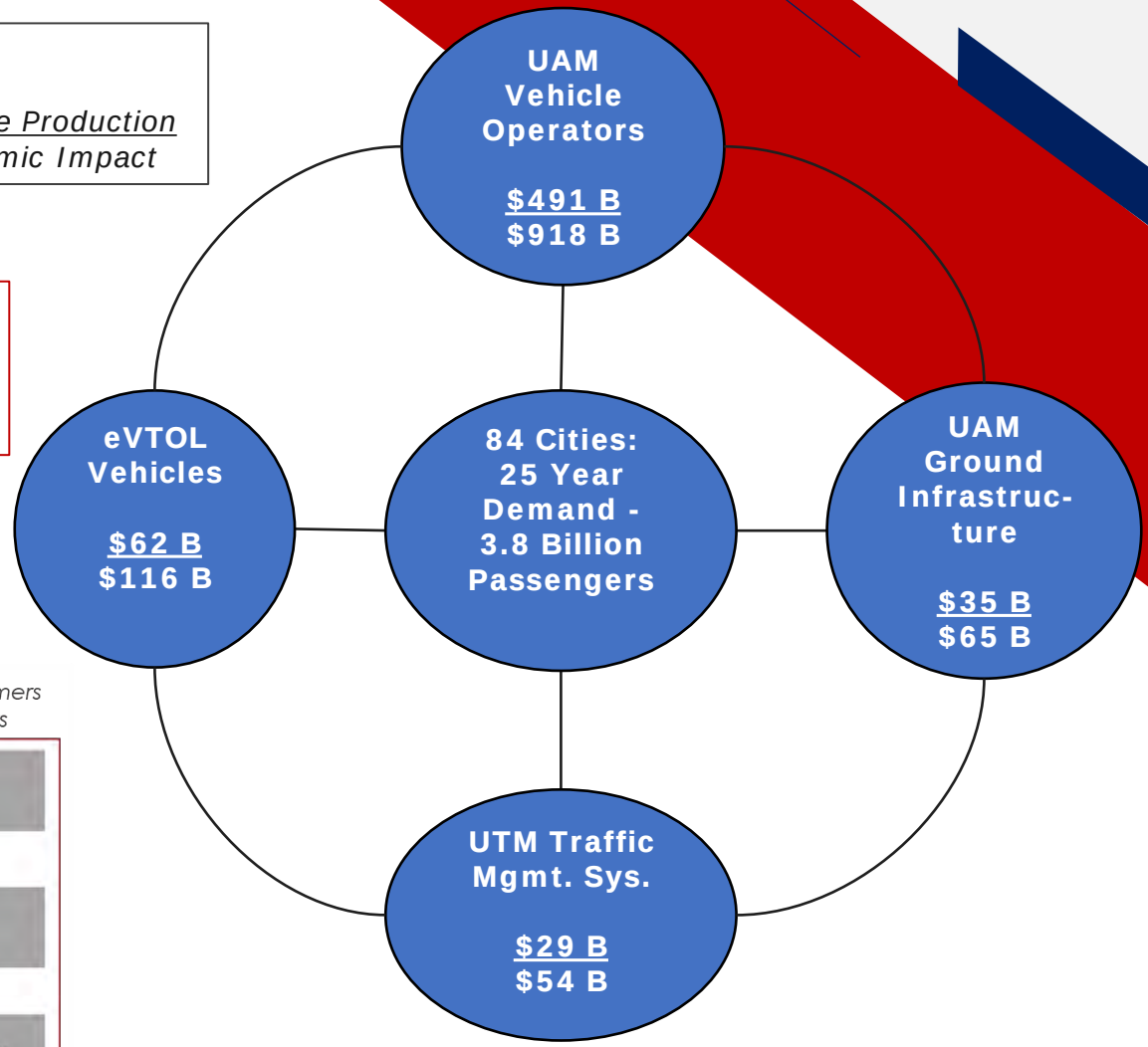
World Markets for UAM

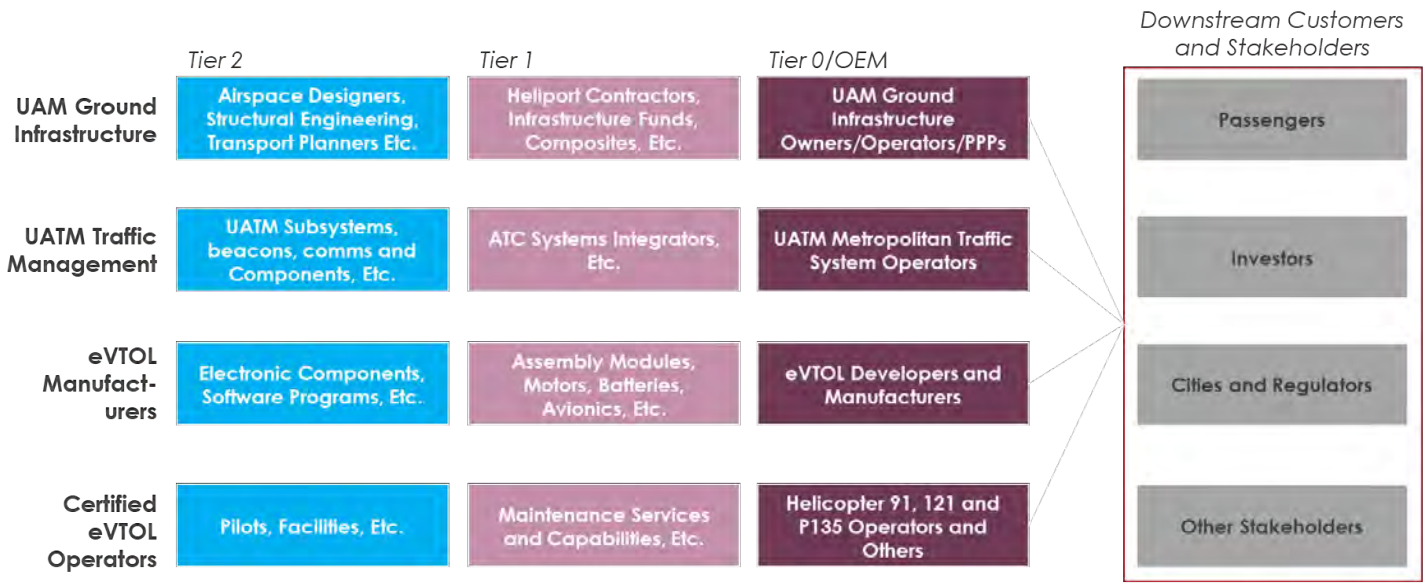
- **UAM Geomatics Analyzed Five Services…**
  - Airport Shuttle
  - On Demand Air Taxi
  - Regional (>200Mi) On-Demand
  - Corporate Campus/Business Aviation
  - Medical/Emergency
- **Four global supply chains were included by necessity to ensure the business case closes …**

Key:

Revenue Production
Economic Impact

Total Global 84 City Opportunity
$1.15 T





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Inputs | Assumptions/Drivers | Modeling and Analysis | Outputs | Findings

City Demographics
- Population and Density
- GDP per Capita
- Age Distribution
- Airline Enplanements
- Congestion
- Taxi Fleets and On-Demand
- Public Transport
- Emergency Facilities
- Airports and Heliports
- Corporate HQs
- Business Aviation Fleets

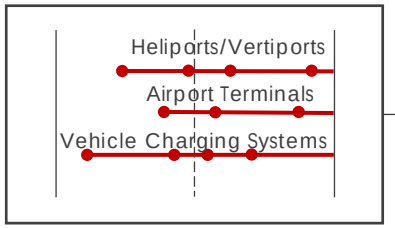
Infrastructure Costs
- Nominal Heliport or needed vertiport Facilities
- Passenger Handling
- UATM Systems
- ANSP Interfaces

Vehicle & Supply Chain
- OEM Fleets
- Electric/Hybrid/Hydrogen
- Battery and Charging
- Power Grid
- Supply Chain and MRO

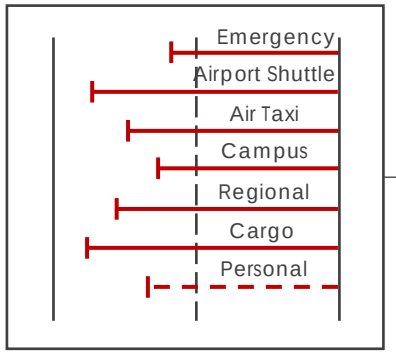
Demand Assumptions
- Phasing
- Pricing

Regulatory and Community Constraints
- Noise
- Safety
- Public Perception

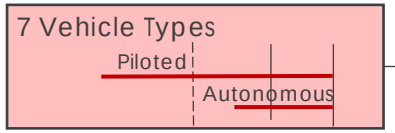
Ground Infrastructure Inputs



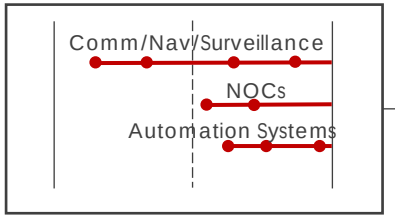
UAM Service Demand Elasticity



eVTOL Manufacturing Supply Chain



UATM Infrastructure Inputs



City PPP Model

- Revenue/P/L Model
- Balance Sheet
- Cash Flows
- CAPEX
- Investment

UAM P135/121 Operator Model

- Revenue/P/L Model
- Balance Sheet
- Cash Flows
- CAPEX
- Investment
- Service Model

UATM Service Model

- Revenue/P/L Model
- Balance Sheet
- Cash Flows
- CAPEX
- Investment
- UTM Infrastructure

Business Case Dashboard

- City PPP Model
- UAM Ops Model
- UATM Model

Economic Impact

- Direct
- Indirect
- Induced
- Catalytic

IMPLAN
MAKE AN IMPACT

Tax Revenues

- Federal
- State/Provincial
- Local
- Sales Taxes

Denotes Unique Supply Chain

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- Business Viability
- Private Investment Likelihood
- Affordability
- Public Acceptance

What is the outlook for 84 of the most significant metropolitan areas globally, and what policy, technology, and financial issues will individually define their success?
What will be the plan, and the minimum investment to move these urban areas to the tipping point of success?
What is the expected size of UAM markets over the next 25 years, but especially the next 5?

Emergency Services

- Medevac
- Facility to Facility
- Search and Rescue
- Surveillance and Traffic

Business Aviation

- Mobility Configurations
- Utilization Strategies
- Benefits
- Shareholder Value

UAM Financial/Economic Tools

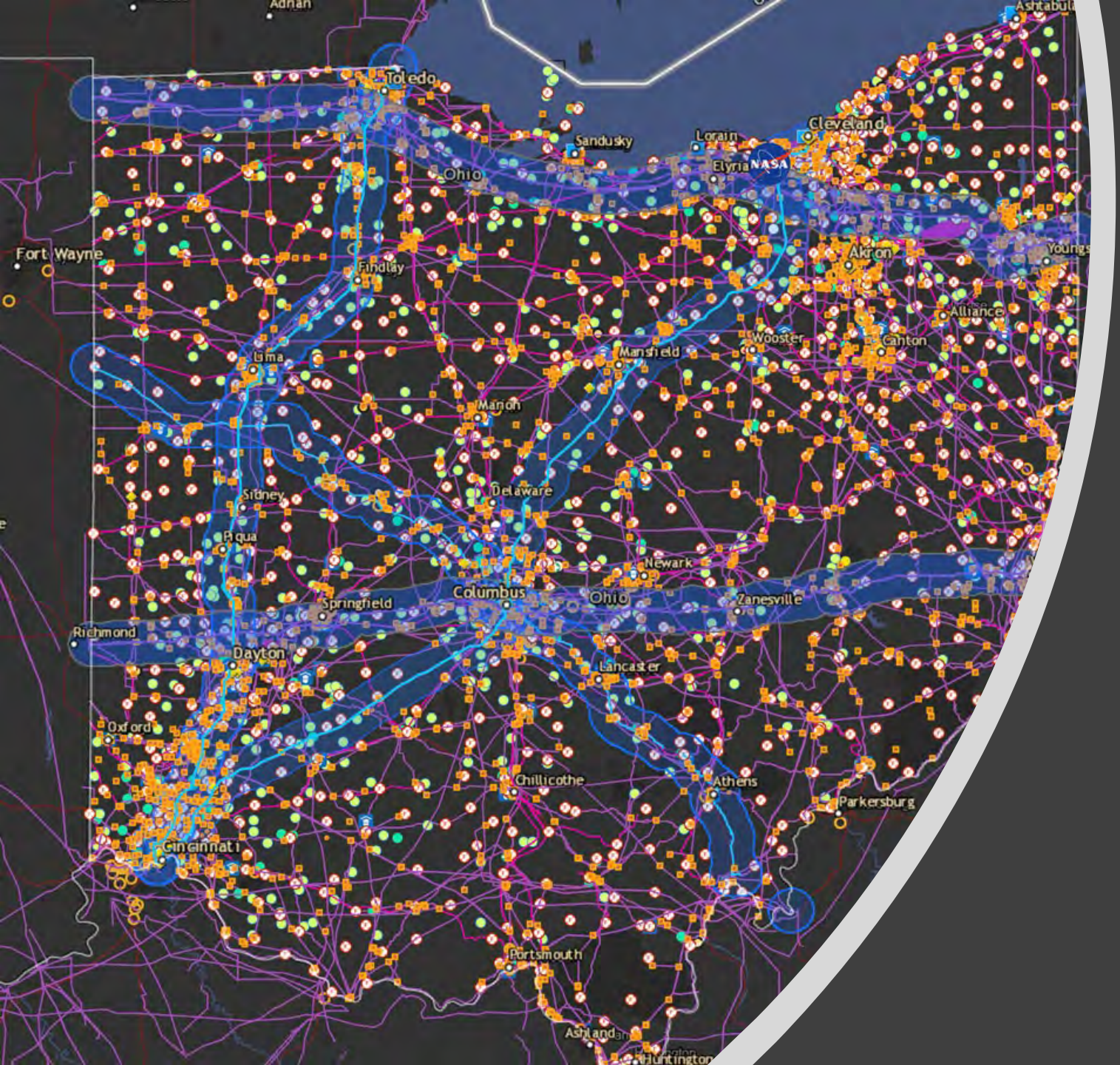
Infrastructure Cost Components

UAM Ground Vertiport Infrastructure Components/Costs

- Network design studies
- Environmental study
- Airspace flight approach study
- Concession agreements
- Secure project financing
- Purchase or lease land
- Construction permitting
- Architectural and engineering
- Site preparation
- Site construction
- Foundation modifications
- Platforms
- Egress, walkways
- Elevators
- Passenger shelters
- Lighting landing systems
- CNS systems (ILS, beacons, etc.)
- IT and security systems
- Perimeter systems
- Parking
- Power grid updates
- FAA (etc.) permitting and certification
- Recharging capability and systems
- Fire suppression systems
- Aeronautical chart preparation
- Etc.

UATM Traffic Management Infrastructure Components/Costs

- UATM interoperability standards and drone/eVTOL agrmts.
- UATM one-time facilities planning
- Site/network optimization study
- Systems specifications
- Power grid studies
- Cyber security architecture studies
- Physical security architecture
- Facilities (offices) rental costs
- Automation Systems and Stations
- Flight Decision Support Tools
- Flight Plan and Flight Operations Database
- SCADA for Systems and Networks
- Computers and Equipment
- Power Grid and Backup Systems
- Network Design and Site Selection Studies
- Weather Information Systems - Areal
- Micro Weather Detection Sensors
- Beacon Navigation Nodes
- Resilient Communications Nodes
- High Density Radar
- Etc.



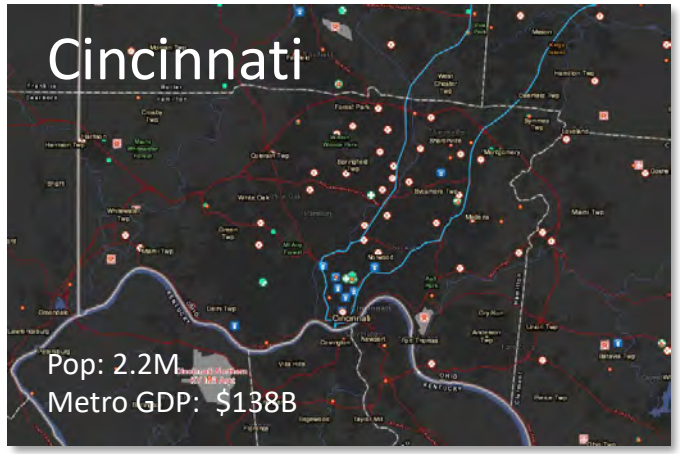
AAM - Geospatial Mapping of the State of Ohio

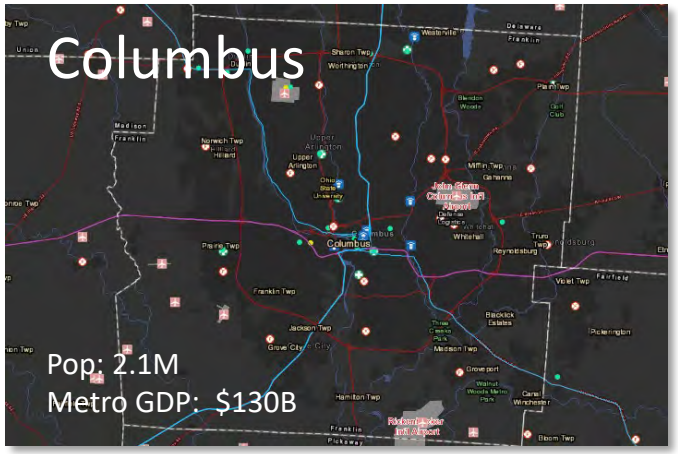
- Geographic Boundaries
- Waterways
- Bridges
- **Property Boundaries**
- **Roads**
- Major Transportation Corridors
- Surface Logistics Centers
- Water Ports
- Public Lands
- Hospitals
- **Blood Banks**
- **Clinics**
- Airports
- High Resolution Airport Facilities Maps
- Heliports
- Military Bases
- Government Buildings
- Transmission Lines
- **Electrical Sub Stations**
- **Traffic Congestion**
- NASA Facilities
- Sports Venues
- **F1000 Corporations**
- Major Manufacturing Facilities
- **Part 91 Facilities and Aircraft**
- **Part 135 Facilities and Aircraft**
- Universities and Colleges
- Shopping Centers
- Music Venues
- **Zoning Districts (Limited)**
- Etc.

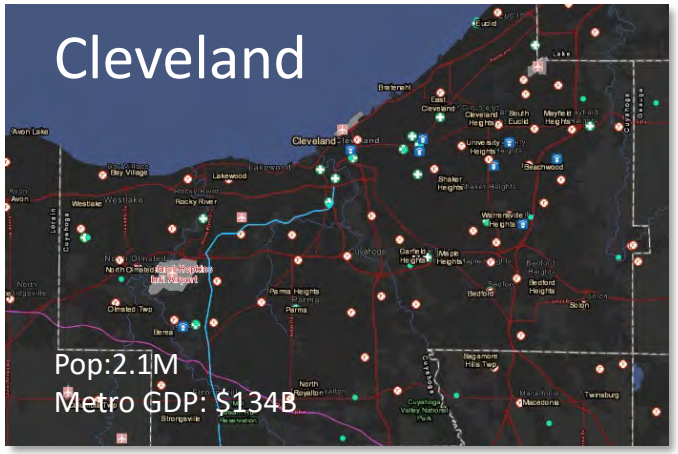
NEXA Capital Partners, LLC
NEXA Capital powers the industry

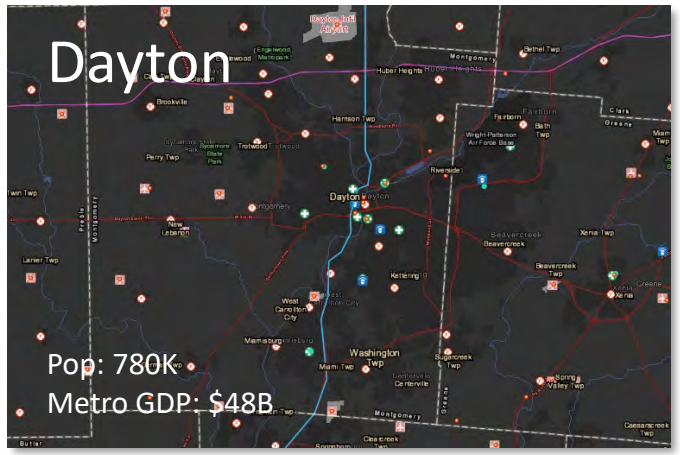
Six Ohio Metropolitan Areas

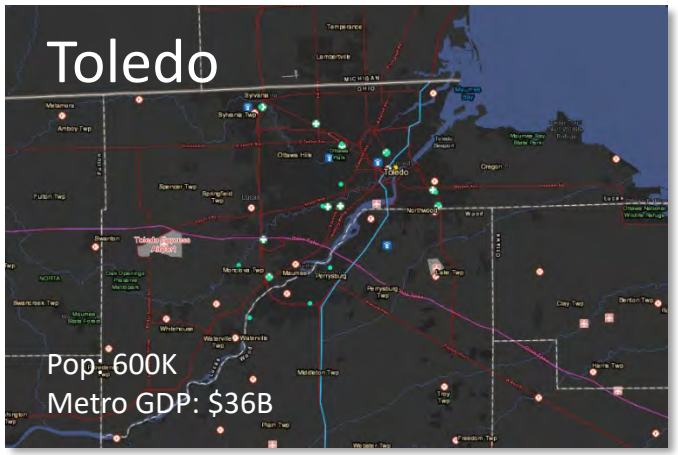
Showing: Hospitals, Blood Banks, Fire Stations, and Universities





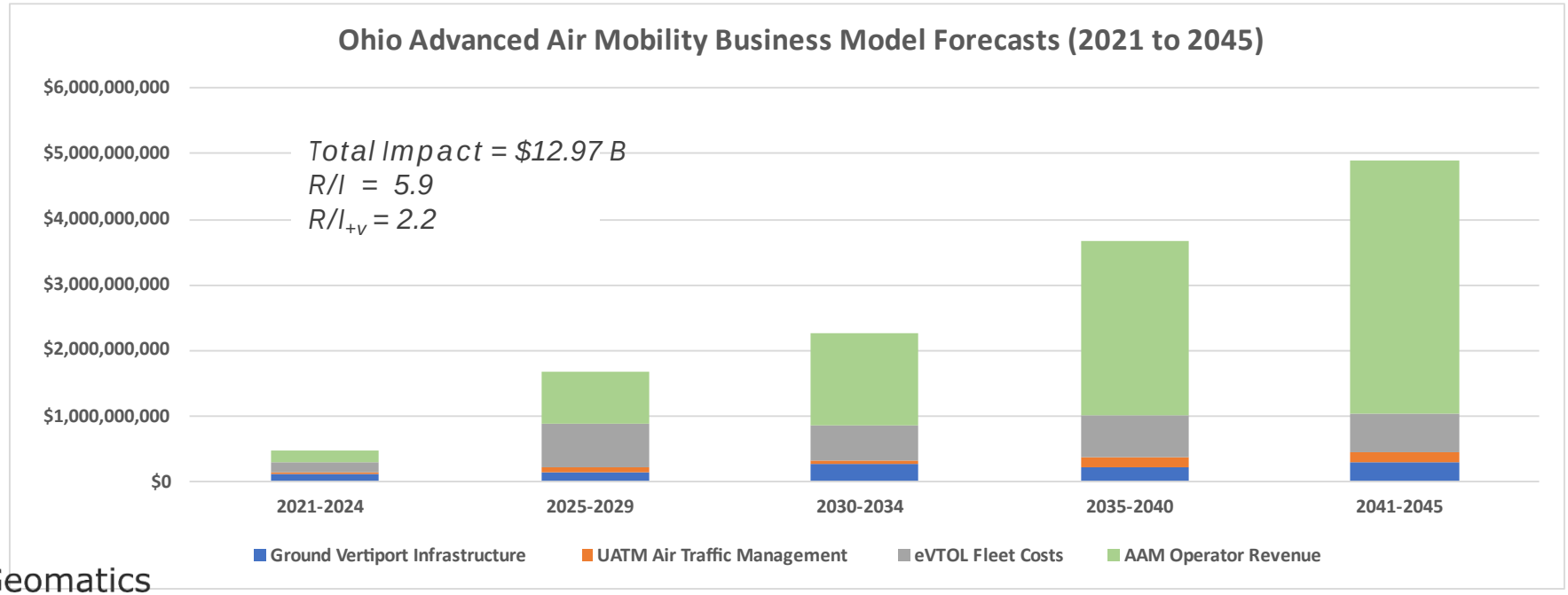






Ohio AAM Forecast - Key Model Outputs

	Year	2021-2024	2025-2029	2030-2034	2035-2040	2041-2045	SUM	Pillar Totals
Demand		214,000	1,697,000	6,559,000	22,264,000	51,698,000	82,432,000	
Ground Infrastructure	Ground Infrastructure OPEX	$30,378,000	$78,782,000	$142,435,000	$213,474,000	$272,558,000	$737,627,000	$1,060,532,000
	Ground Infrastructure CAPEX	$80,366,000	$74,474,000	$118,745,000	$15,065,000	$34,255,000	$322,905,000	
UATM	UATM Cost OPEX	$4,898,000	$7,299,000	$33,767,000	$106,098,000	$109,655,000	$261,716,000	$464,670,000
	UATM Cost CAPEX	$23,614,000	$69,156,000	$35,421,000	$40,481,000	$34,281,000	$202,954,000	
AAM Operators	Passenger Revenues	$52,371,000	$350,162,000	$623,322,000	$1,363,453,000	$2,220,514,000	$4,609,822,000	$8,917,935,000
	Emergency Services Revenues	$50,713,000	$253,564,000	$443,737,000	$633,910,000	$813,842,000	$2,195,766,000	
	Cargo Revenues	$75,999,000	$197,417,000	$348,617,000	$670,269,000	$820,044,000	$2,112,347,000	
Vehicles	Vehicles	$147,000,000	$646,600,000	$516,389,000	$631,956,000	$587,152,000	$2,529,097,000	$2,529,097,000
Ohio Grand Total		$465,339,000	$1,677,454,000	$2,262,433,000	$3,674,707,000	$4,892,302,000	$12,972,234,000	$12,972,234,000



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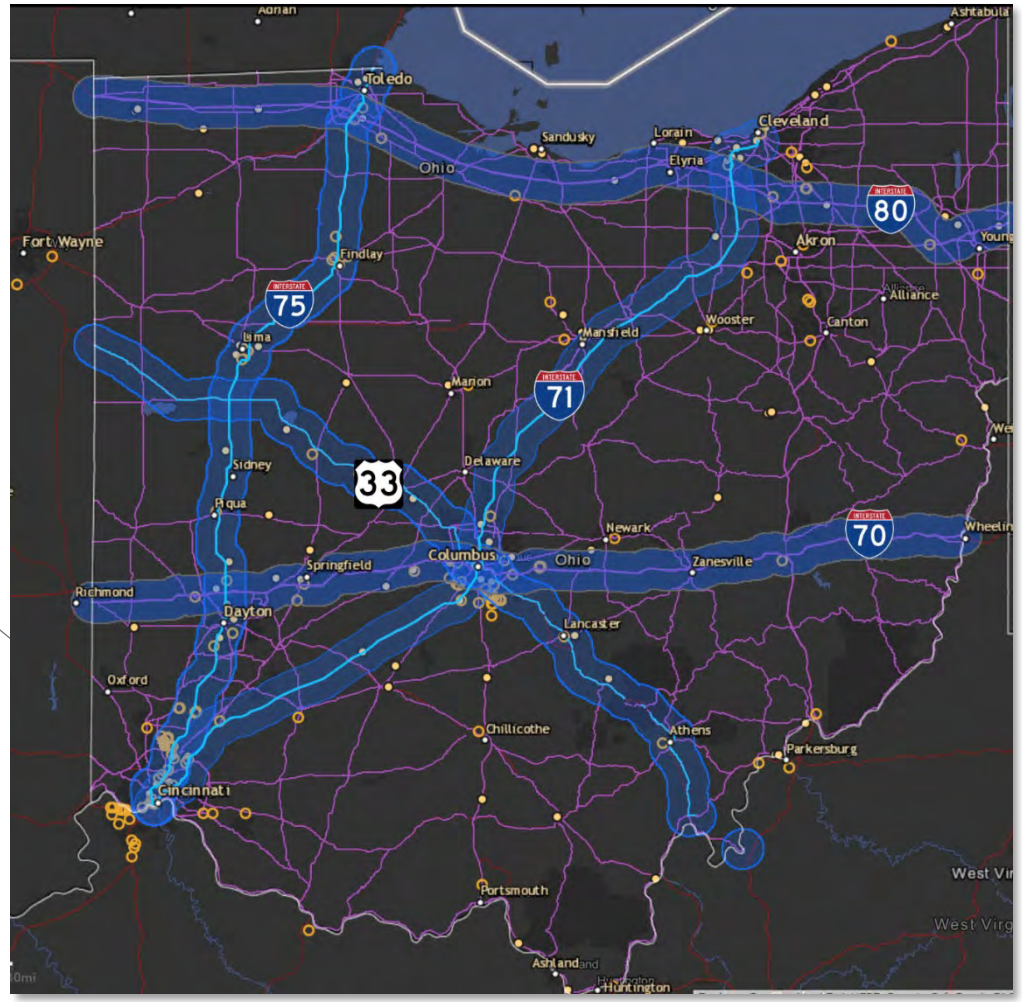
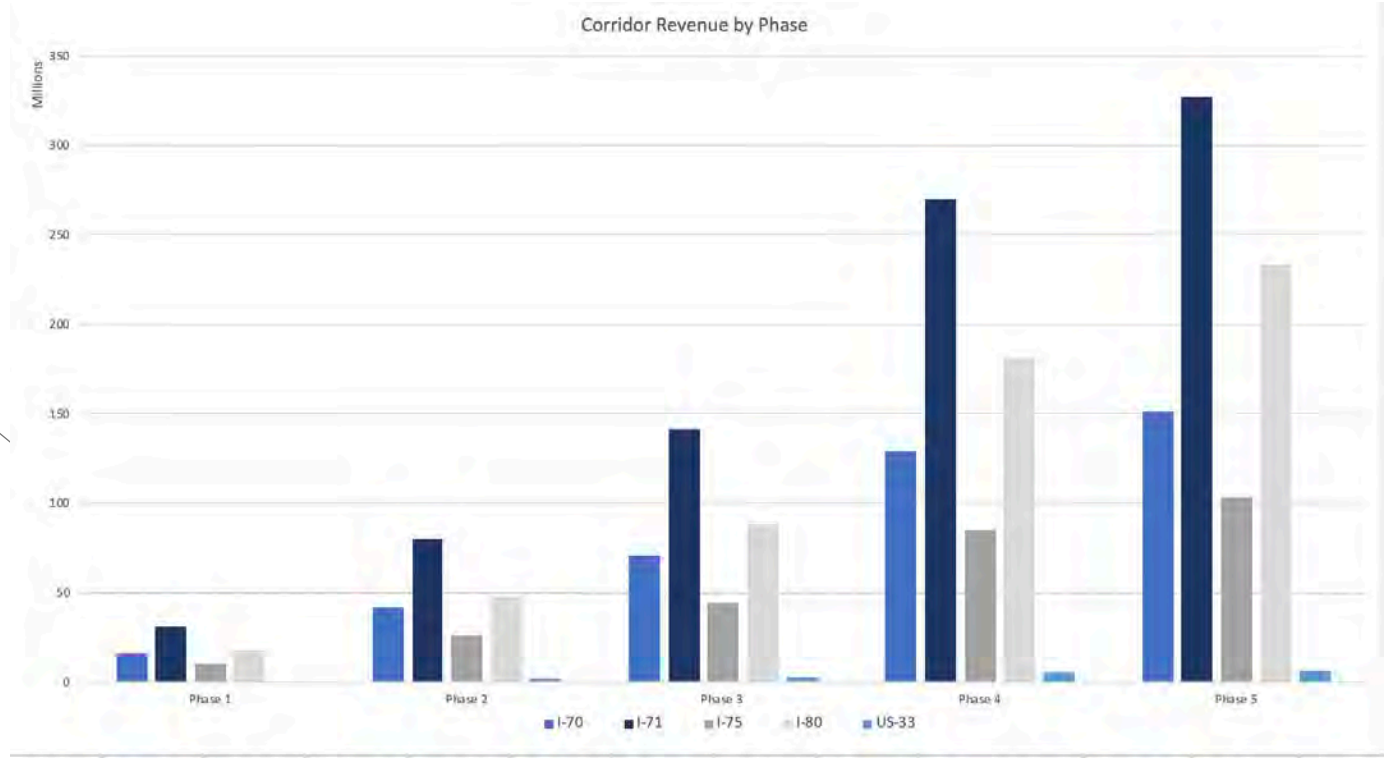
Five Logistics Corridors



The 5 major corridors in Ohio connect metropolitan regions, transporting both people and goods across the state

These corridors provide an important starting point for visualizing Cargo AAM operations, as well as Regional Air Mobility services

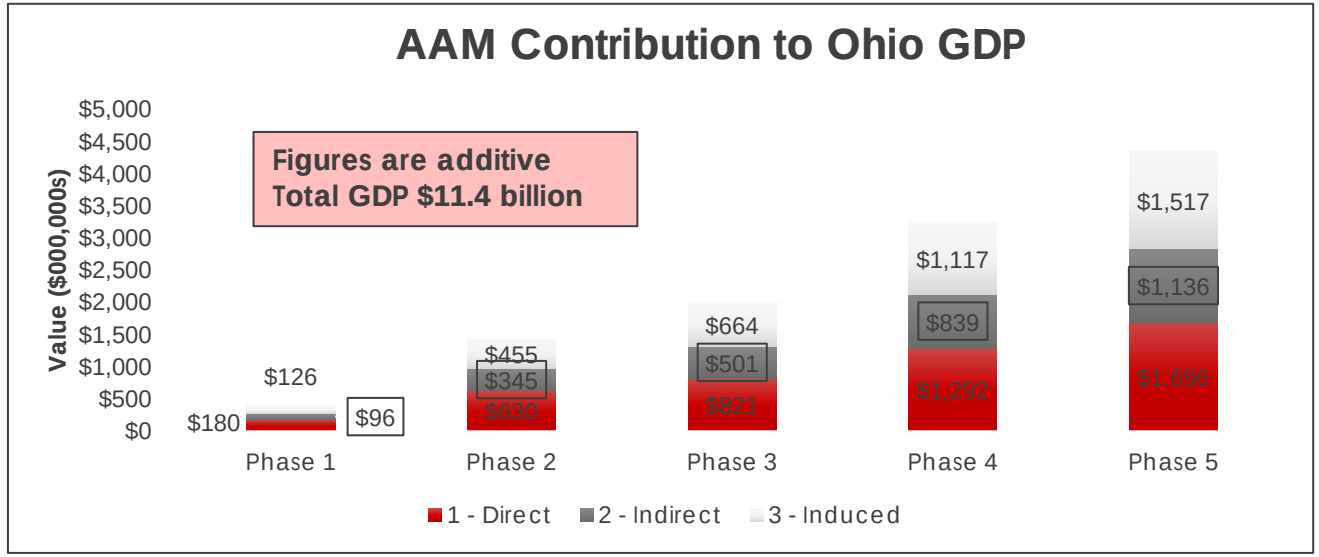
Ohio Corridor Logistics Revenues (2021 – 2045)

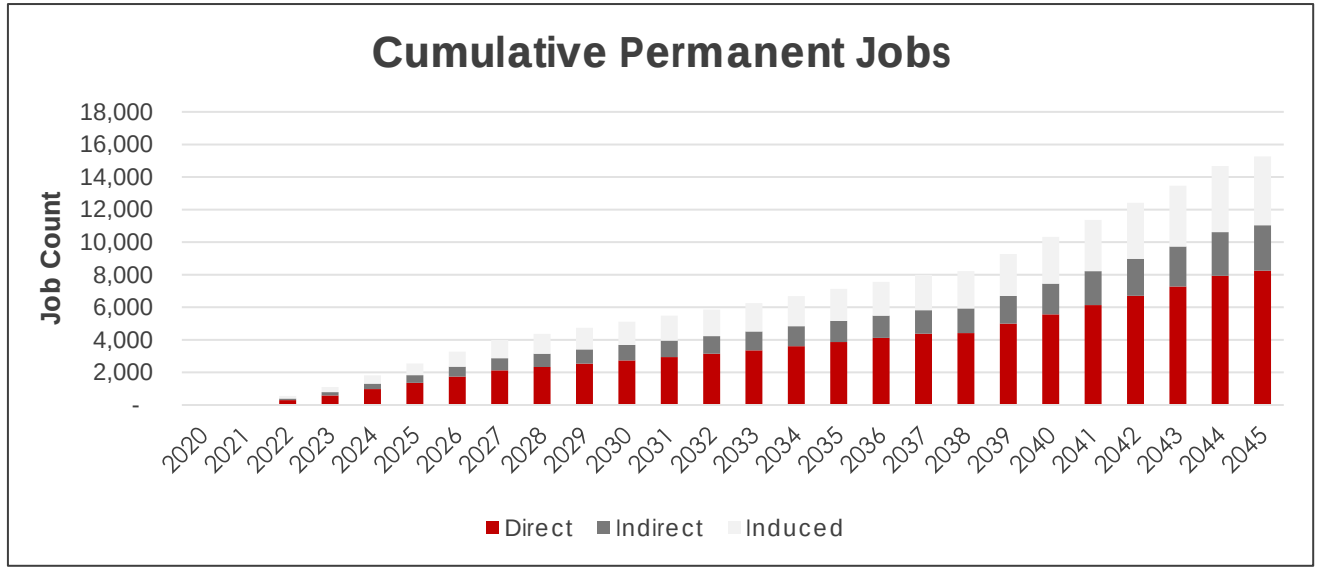


Observations:

- Cargo categories:
  - Time sensitive
  - High Value
  - Cargo Weight 50, 500, 1,000 Lb.
- US-33 is “Smart Corridor” between Columbus and Athens
- Other corridors carry vastly more cargo and freight traffic on daily basis
- I-71 carries most cargo traffic today
- I-80 is projected to grow more rapidly over forecast period

Ohio Economic Impact Results: GDP and Jobs





Observations:

- Ohio's GDP will increase by an estimated 1.63% annually over 25 years
- By 2045, AAM will have created over 15,000 new permanent jobs
- New and existing industries will create high-paying jobs in aviation, engineering, and finance

Top 10 Occupations (Not in Order)
Engineering, Intelligent Transportation Systems
AAM Operators (Pilots, etc.)
AAM Operational Support (Maintenance, etc.)
Vehicle Design and Manufacturing
Business and Financial Operations
Quality Control and Safety Engineering
Medical and Supporting Services
Travel Support Services
Hospitality
All Other

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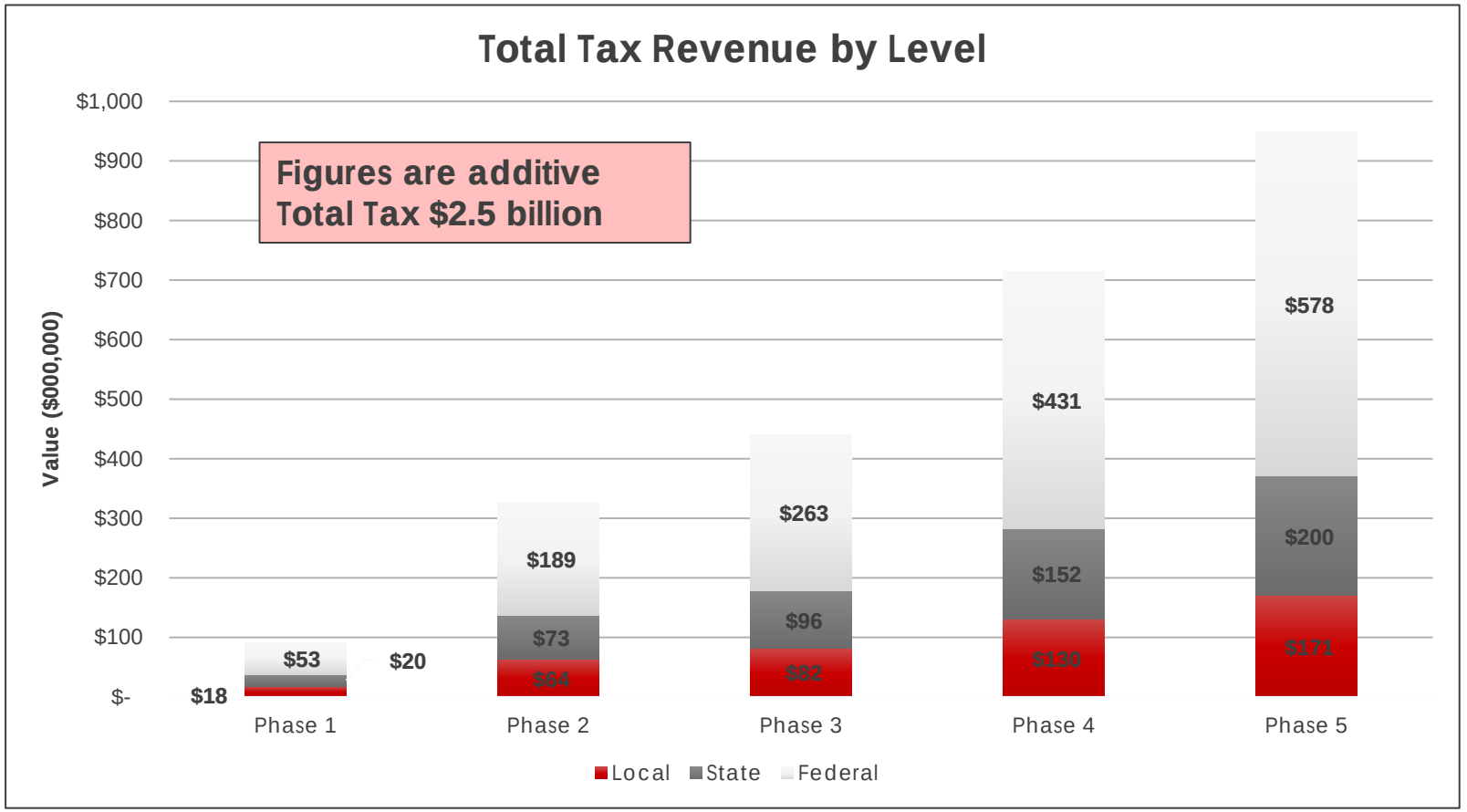
Ohio Economic Impact Results: Tax Revenues



Observations:

- Incremental economic growth produces majority of tax revenues; 2019 tax rates applied, over 25 years
- Cities, townships, and counties will earn $464 million in taxes
- Ohio will earn $541 million in state taxes
- Federal taxes increased by $1.5 billion

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Thank **You!**

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UAM Geomatics, LLC
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GETTING STARTED

DRONES IN BUSINESS

TX DRONE CO.

FOCUS ON MAPPING

WHAT'S COMING

TX DRONE CO.

Proud Member of AUVSI - Lone Star

AUVSI ALL THINGS UNMANNED

The **Association for Unmanned Vehicle Systems International** (AUVSI), the world's largest nonprofit organization dedicated to the advancement of unmanned systems and robotics, represents corporations and professionals from more than 60 countries involved in industry, government and academia. AUVSI members work in the defense, civil and commercial markets.

FAA UAS SYMPOSIUM

AUVSI UNMANNED SYSTEMS DEFENSE PROTECTION SECURITY

robonation

AUVSI XPONENTIAL ALL THINGS UNMANNED

Texas Drone Company

Drone Service Provider Serving all of Texas

Survey & Mapping - Topographic and LiDAR Aerial Surveys

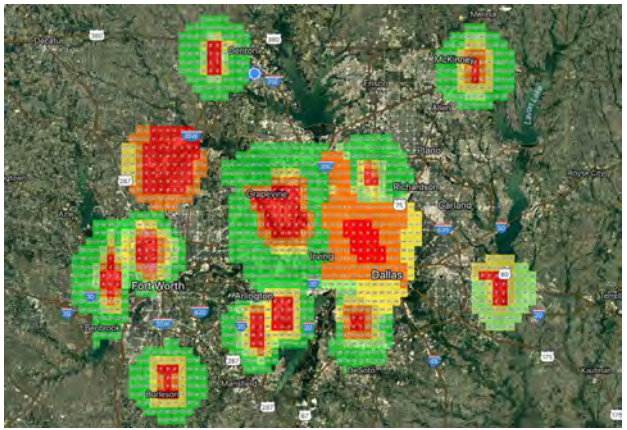
Aggregate Inventories - Sand & Gravel, Asphalt, Rock Quarries,

Energy - Wind Turbine Inspections, Oil & Gas Modeling

DRONES IN BUSINESS

Any commercial drone use must be conducted by a Part 107 certificated pilot
Basics rules & regulations:

- 400’ Maximum Altitude
- Drones must be registered.
- Required Airspace Authorizations
- Operate within Line of Sight



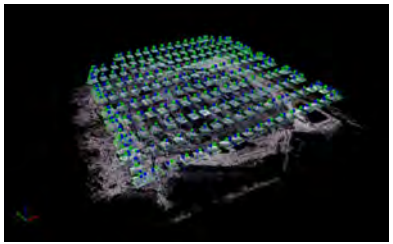
DRONES IN BUSINESS

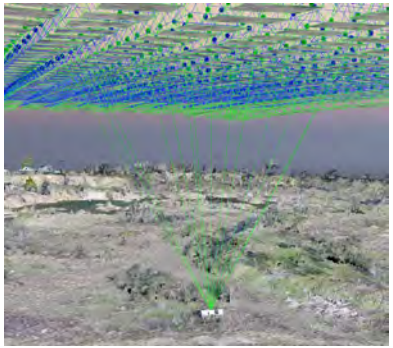
TX DRONE CO.

FOCUS ON MAPPING

TX DRONE CO.

THE BASICS





Equipment

Software

Planning & Flight

Processing

www.txdroneco.com

FOCUS ON MAPPING

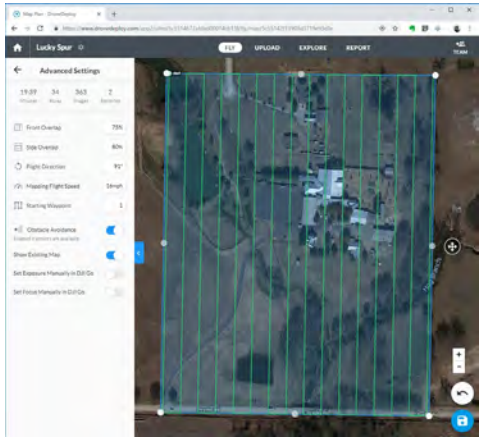
FOCUS ON MAPPING

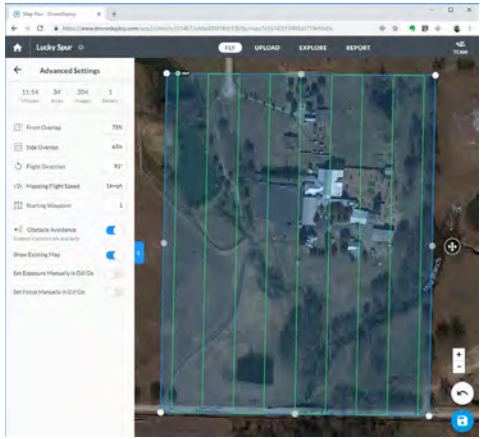
Optimum Settings (Phantom 4 Pro/RTK)

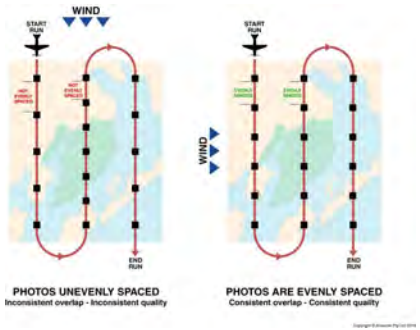
Altitudes
400’ - 1.2in/pixel
300’ - .92in/pixel
200’ - .66in/pixel
100’ - .33in/pixel

Image Overlap
75 front / 65 side to side - 2D Mapping
80 front / 70 side to side - 3D Mapping

On-Site Adjustments
Altitude Infringements
LOS Issues
Wind - Direction of flight







FOCUS ON MAPPING

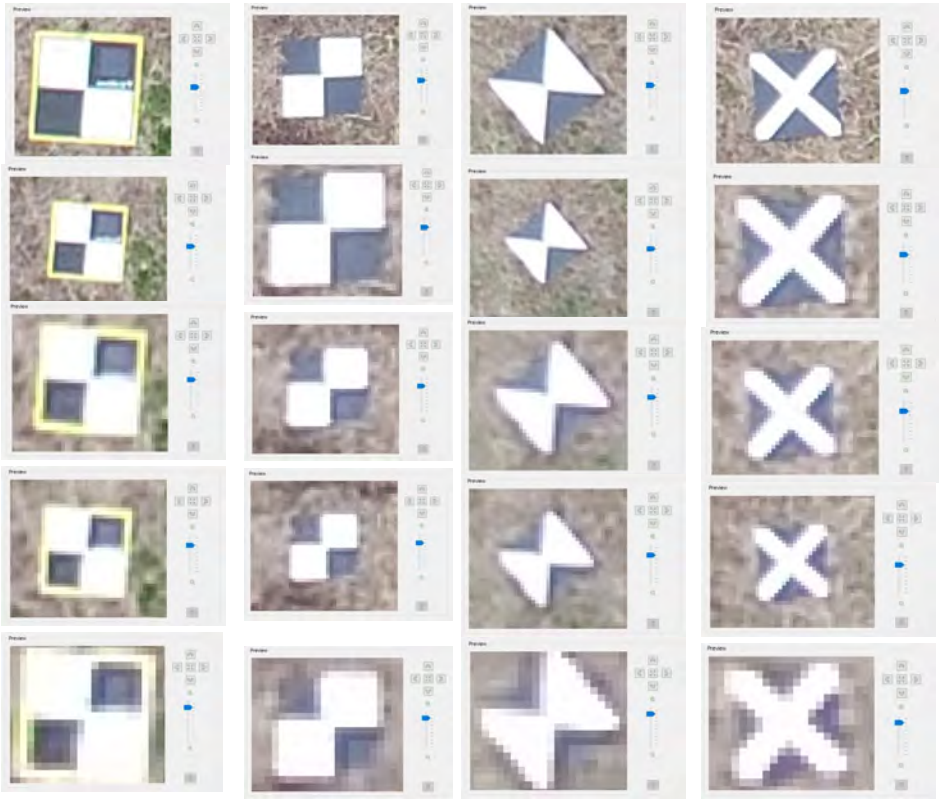
200ft

250ft

300ft

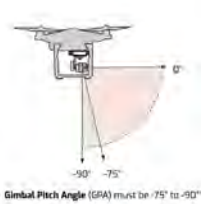
350ft

400ft



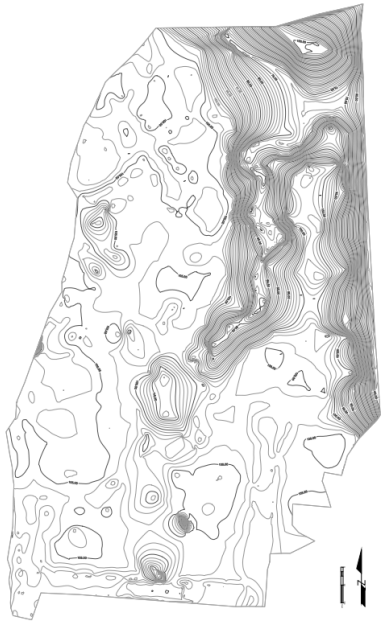
FOCUS ON MAPPING

Double Grids



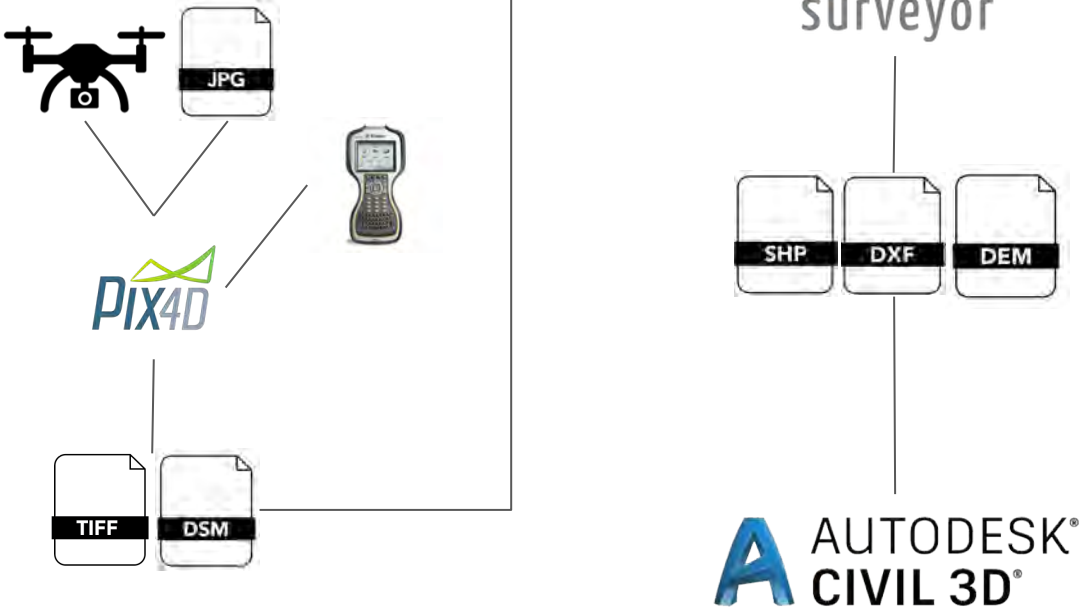
LIDAR

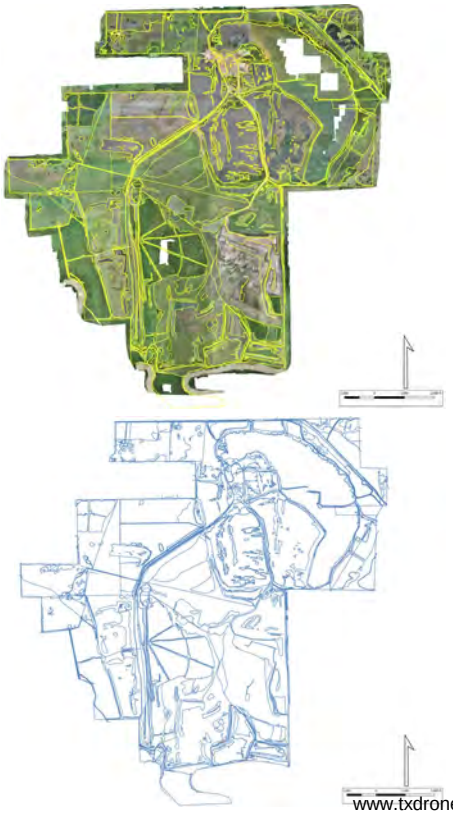
PHOTOGRAMMETRY



FOCUS ON MAPPING

Deliverables





WHAT'S COMING

LIDAR

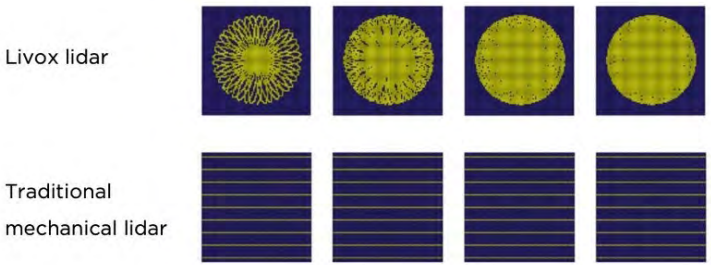
Absolute Accuracy
20 / 30 mm RMSE @ 75m Range
250m+ laser range
5 Returns / 200k Points/sec.

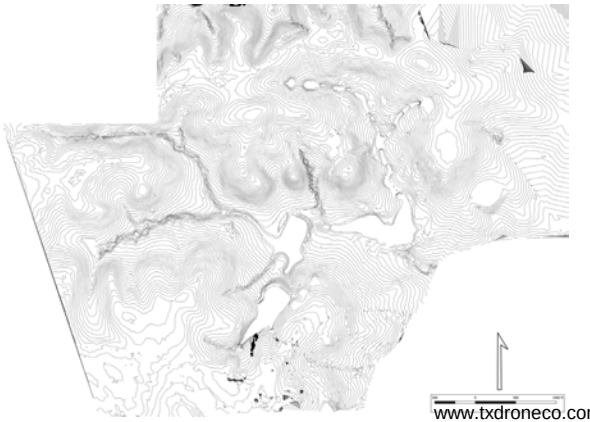
$150k+

WHAT'S COMING

LIDAR

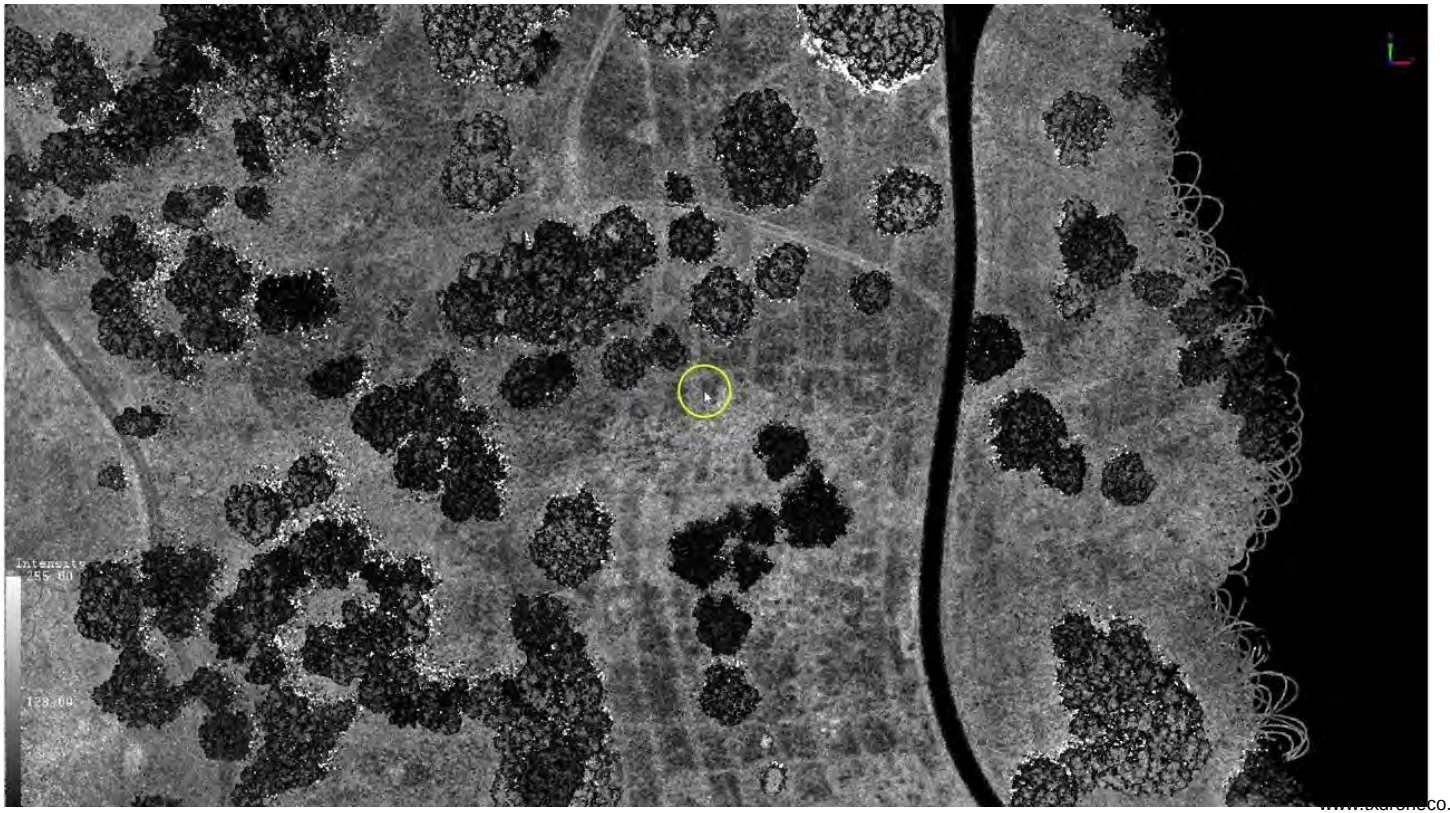
Absolute Accuracy
20 / 30 mm RMSE @ 75m Range
230m+ laser range
3 Returns / 480k Points/sec.





WHAT'S COMING

LIDAR EXAMPLE POINT CLOUD



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DAC Tasking Group 9; Improving Low Altitude situational awareness for manned and unmanned aircraft Subgroup 3

Presenter: Mark Colborn, DAC Member & Dallas PD

Note: The Tasking Group 9 is aware and members are participating in Tasking Group 10 regarding Gender Neutral Language recommendations for the FAA and aviation community. We will use the term UAS Operator in this set of recommendations and will use agreed-to terms in the future. By "UAS Operator" we include the individual who is controlling the flight of the UAS, frequently called the Remote Pilot in Command.

Task Group #9 Remit

Tasking Group 9 FAA Tasking:

- *Opportunity*: Can Remote ID be used to increase situational awareness between manned aviation that routinely operates at low altitudes away from airports and UAS operating in the same airspace?
- FAA only received 30 responses to their RFI issued in February 2020. Tasked DAC to study issue further.
- *Tasking*: DAC to engage operators in low altitude airspace to obtain feedback on how remote identification might be used to increase situation awareness and use this feedback to develop recommendation on how the FAA can address responses to the RFI.

Sub Group Remits

Sub-Group 1 (AMA, AOPA)

Review available RFI responses; develop survey to send to low-altitude community; interview subject matter experts in industry, government, academia.

Sub-Group 2 (BNSF, UPS)

Explore the applicability of existing/developing technologies to manned and unmanned aircraft including range, human factors, and cost.

Sub-Group 3 (Dallas PD, Skyward)

Identify areas outside of the scope of Task Group 9 that are important to consider with respect to situational awareness in low-altitude airspace

- How can information be better used to make the airspace safer?
- Are there outstanding policy or regulatory discussions?

- **Our Recommendations span immediate to longer term**
- **Each Recommendations was created to assist with the evolution of the Unmanned Traffic Management system**

Voluntary ADS-B-In Use by UAS Operators	***Radio use by UAS Operators***	***Voluntary Onboard Access for Low Altitude Aviators***	***Voluntary Notify & Fly***	***Ground Based RID-In Detection Network***

#1) Propose the FAA encourage UAS Operators, developers and manufacturers to implement and use ADS-B-In technologies.

- **Voluntary Use**
- **Builds on UTM ConOps v2.0 Scenario *V2-3:*** *Option 3 – UAS and Manned Aircraft On-Board Cooperative Equipment*
- **Primary stakeholders**: Both Manned & UAS Operators
- **Considerations:**
  - Leverages an existing technology
- **Work required to make this a reality**
  - ADS-B technologies exist and are on the market today
  - FAA should encourage ADS-B equipage

#2) Propose the FAA considers amending AC 107-2A, Instructions on Radio Communications and How to obtain a FCC Restricted Radio Telephone Operator's License.

- **Builds on UTM ConOps v2.0 ScenarioV2-3**: *Option 3 – UAS and Manned Aircraft On-Board Cooperative Equipment*
- **Primary stakeholders**: Both manned & UAS Operators. Radio monitoring and usage is of value for all airspace, controlled and uncontrolled
- **Considerations:**
  - UAS Operators do not meet the FCC requirements of Aircraft Station restriction:
  - 47 C.F.R, Part 87 defines Aviation Radio Services, including Aircraft Stations and Ground Stations
  - Leverage training available with the FAA's WINGS program (As a method of informing Part 61 Pilots about UAS Operations and RID).

#3) Voluntary On-board access to Remote ID information for Low Altitude Aviators

- **Propose the FAA develop an acceptance and/or certification path for voluntary adoption of low-cost on-board remote-ID monitoring capability for manned aircraft.**
- **Builds on UTM ConOps v2.0, Scenario V2-3**: *Option 3 – UAS and Manned Aircraft On-Board Cooperative Equipment.*
- **Primary stakeholder:** All aircraft pilots and UAS Operators. Additional stakeholders include all UTM participants, public safety, cities, airports and the general public
- **Considerations:**
    - Suggest the implementation might include current infrastructure and technology; EFB, NORSEE and be optionally TSO'ed
- **Work required to make this a reality**
    - FAA development of an acceptance and/or certification path for voluntary low cost on-board Remote ID monitoring capability for manned aircraft.
    - Industry production and sale of on-board RID receivers and software for aircraft pilots and owners
    - Leverage Training available with WINGS program

#4) Propose the FAA consider Notify & Fly as a candidate for UPP 3 validation.

- **Voluntary Use**
- **Builds on UTM ConOps v2.0, Scenario V2-3**: *Option 4 – Voluntary Passive UTM Participation*
- **Primary stakeholders:** UAS Operators as well as manned aircraft pilots
- **Considerations:**
  - UAS Operator and aircraft pilot enters flight intent into app
  - Facilitates increased UAS communications for un-towered, uncontrolled airspace
  - N&F could be a 1st step to educating UAS communities on rigor of UTM
- **Work required to make this a reality**
  - Recommendation to FAA to evaluate how to scale LAANC-like features in uncontrolled airspace
  - Uncontrolled airports may be good locations for proofs of concept
  - Leverage Training available with WINGS program (As a method of informing Part 61 Pilots about Notify and Fly)

#5) Ground Based Detection Network. Recommendation: Propose the FAA explore methods by which broadcast Remote ID information can be received by ground based Remote ID receivers and transmitted to UTM systems, and when appropriate, to manned aircraft via TIS-B or other mechanisms.

- **Builds on UTM ConOps v2.0, Scenario V2-3: *Option 2* – *Ground-Based Detection for UAS and Manned Aircraft***
- **Primary stakeholders:** Manned aircraft pilots and UTM participants, public safety, cities, airports and the general public
- **Considerations:**
  - Ground based first installations would be near airports & sensitive installations
  - Adds detection of VLOS operators
  - Appropriate filtering would be required for TIS-B.
- **Work required to make this a reality**
  - Development of regulations and UTM industry standards for small UAS
  - Industry development of networked receivers and connection to UTM infrastructure
  - Installation of ground based networked receivers

Thank you for all the work Sub-Group #3!

- A great team with a broad and deep aviation background agreed on these recommendations.

- Academy of Model Aeronautics
- Airline Pilots Association
- Aircraft Owners & Pilots Association
- Agriculture Aviation Organization
- Dallas Police Department
- DJI
- Drone Service Provider Alliance
- FPV Freedom Coalition
- Helicopter Association International
- Influential Drones, Inc.
- Kittyhawk
- Los Angeles Department of Transportation
- National Agricultural Aviation Association
- National Air Traffic Controllers Association
- Northeast UAS Airspace Integration Research Alliance
- Praxis Aerospace Concepts International, Inc.
- Robotic Skies
- Skyward
- University of Alaska Fairbanks
- Wing
- XiDrones, Inc.

Legislative Update

Nicholas Allen

North Central Texas Council of Governments

UAS Safety and Integration Task Force

July 27, 2021

87th Legislative Session

HB 1758 (Krause) - Relating to the operation and use of an unmanned aircraft.

- Defines “drone”
- HB 1758 also ensures that law enforcement agencies seeking to use drones must adopt written policies detailing the agency’s use of force via drone and transmit those policies to the Texas Commission on Law Enforcement annually.

SB 149 (Powell) - Relating to the prosecution of the offense of operation of an unmanned aircraft over certain facilities.

- Also adds airports and military installations to the list of critical infrastructure

SB 763 (Powell) - Relating to the creation of the urban air mobility council.

- TxDOT and the TTC must appoint a UAM council to study policies that will facilitate integration
- North Texas has been identified as an early test location for UAM

Questions and Comments

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