Automated Freight – Challenges and Opportunities

Pennsylvania Automated Vehicle Summit 2018

Session 2b. "Goods Movement, Logistics, and Automated Freight"

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Group Leader: EcoTransportation and Alternative Systems – Virginia Tech Transportation Institute

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Trends Impacting Freight

Manufacturing and Marketing Changes

- Manufacturing
  - Origins – Global economy
  - Just-in-time
- How we buy things
  - E-Commerce
- Goods movement
  - Port-centric
  - More handling & transfers
  - Timeliness

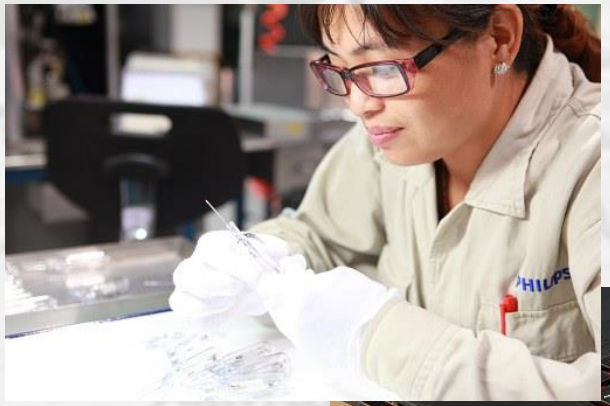
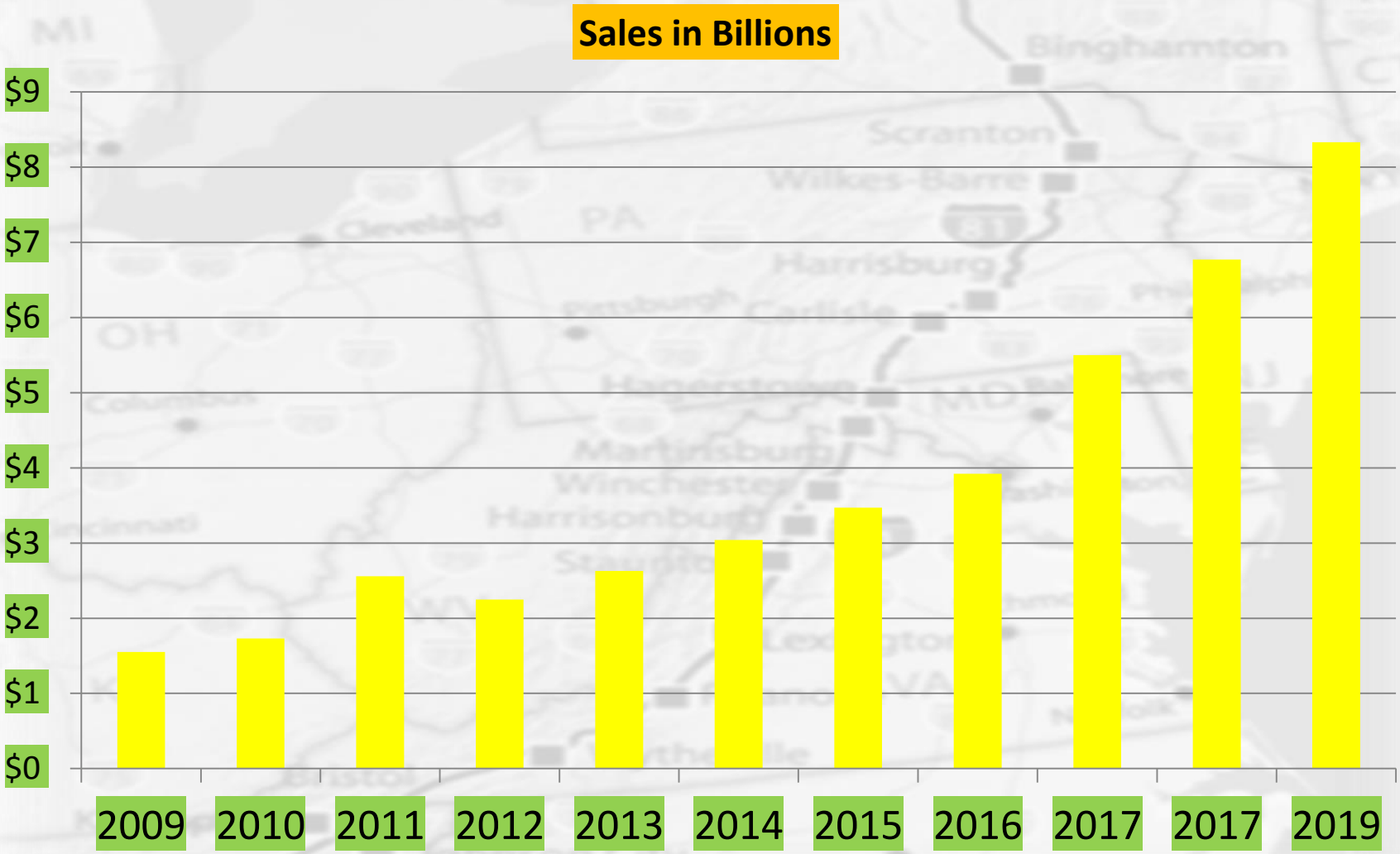


Photo: Ray Hensel

E-Commerce Sales Growth



Source: Mike Ross, 2017

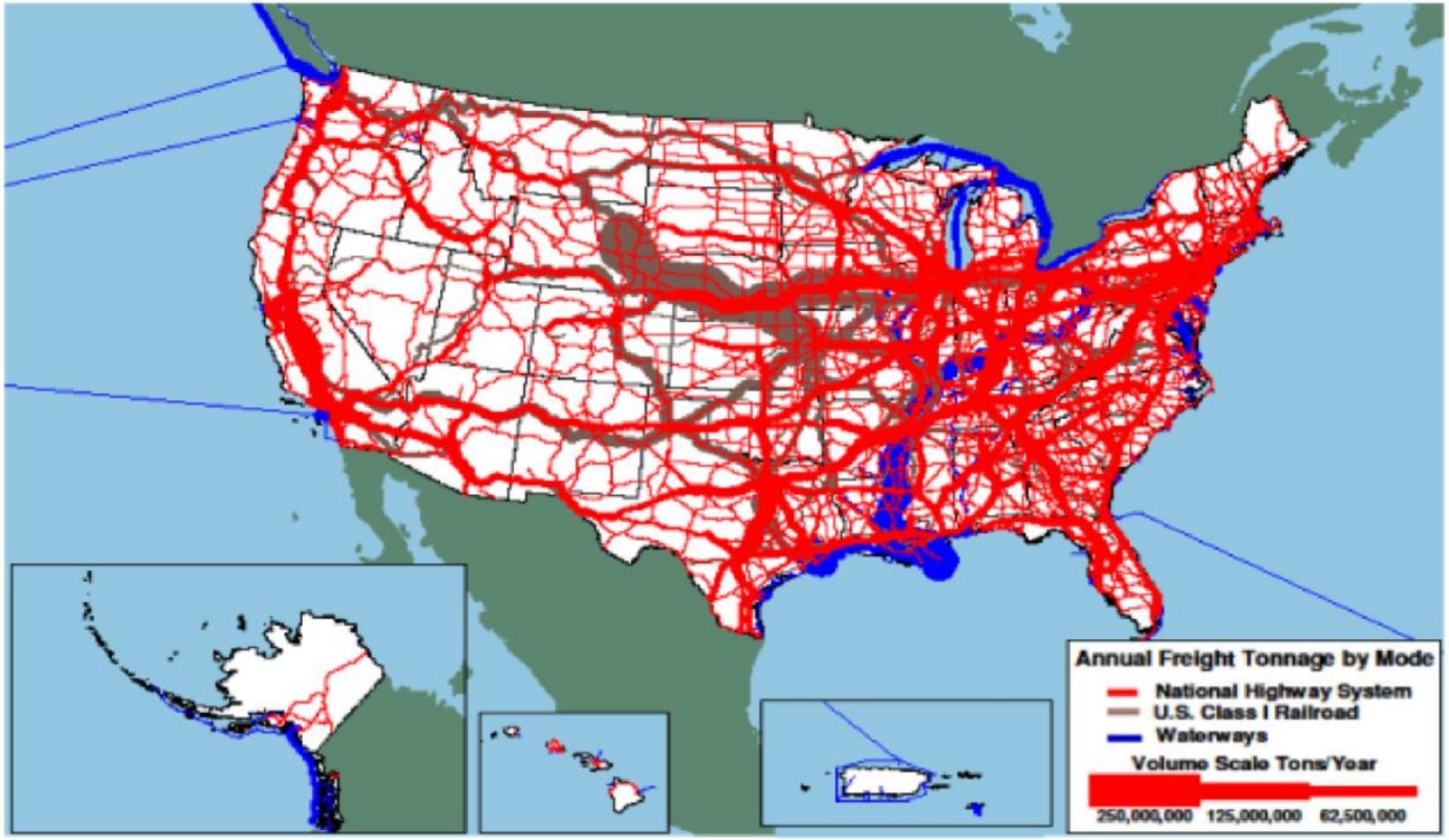
U.S. Truck Freight Numbers

- USDOT projects that overall freight levels will increase 40% by 2045
  - Truck tonnage will increase 44%
- Over 500,000 trucking companies in the US
  - 97% have fewer than 20 trucks
- 70% of all goods (by weight) in the US move by truck
  - 97% of all consumer goods
- Future modal shares are expected to shift more to truck
  - Over 80% of US communities are served only by truck
  - If rail intermodal use doubled by 2020, market share will still be less that 2%

Source: D. Bennett, 2017

Freight by Mode

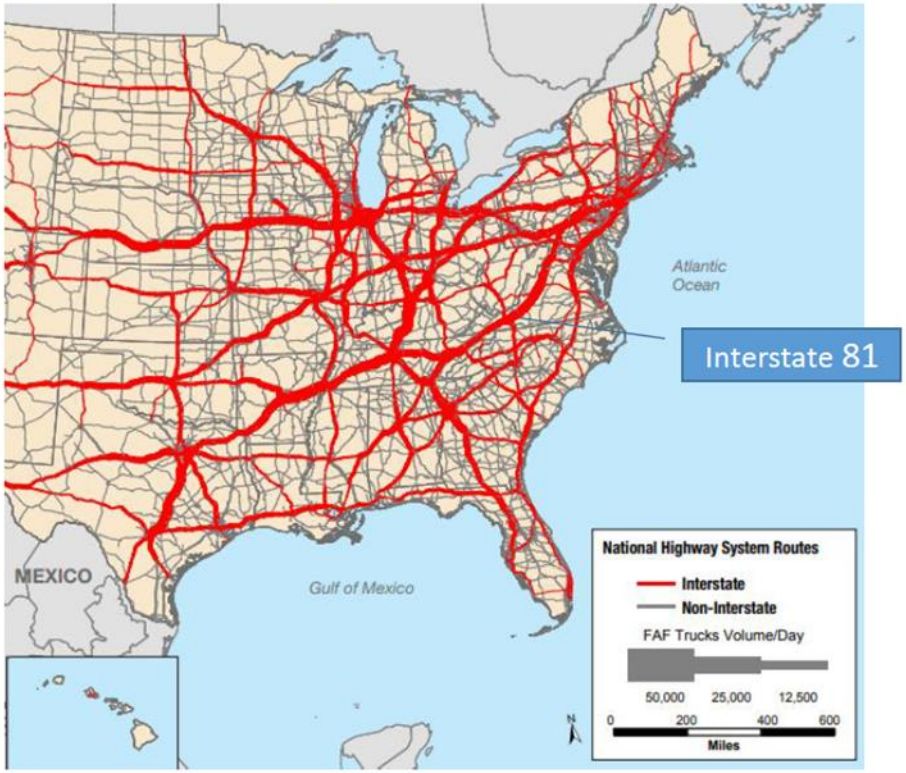
Exhibit 1-17 Tonnage on Highways, Railroads, and Waterways, 2010



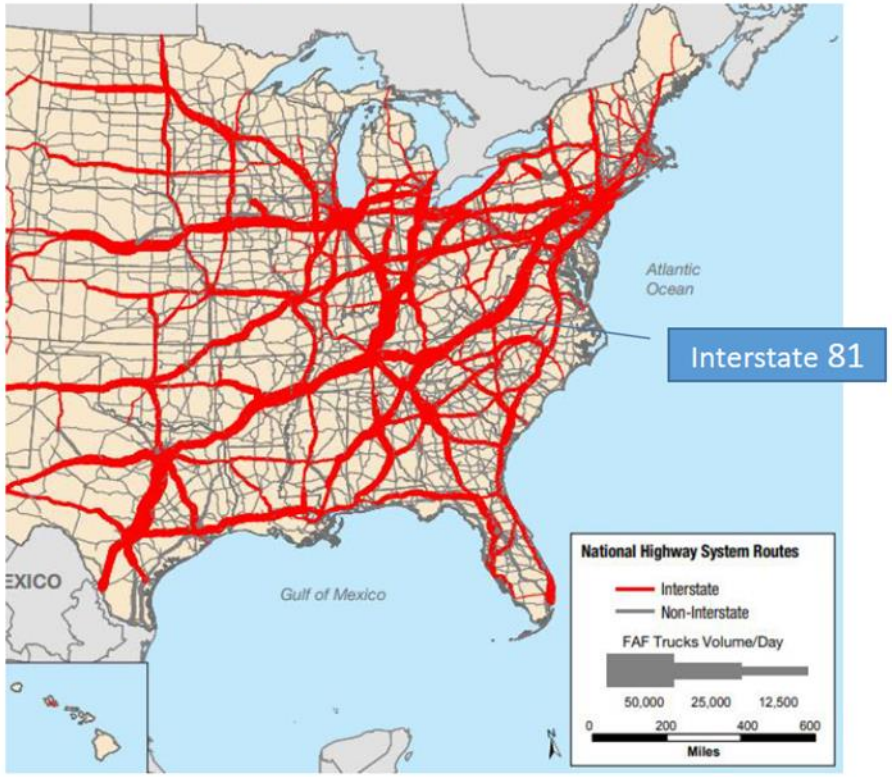
Highway Freight Growth

Truck Freight 2011 vs 2040 (projected)

Average Daily Long-Haul Traffic on the NHS: 2011



Average Daily Long-Haul Traffic on the NHS: 2040

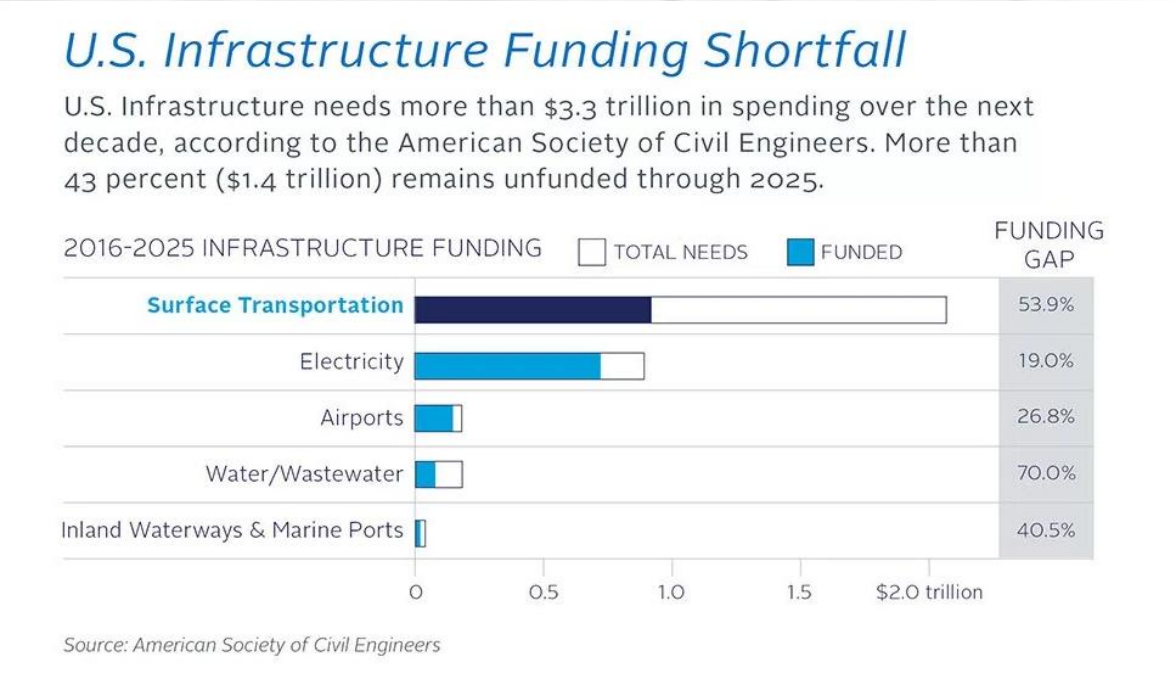


Sources: Freight Facts and Figures 2013: https://ops.fhwa.dot.gov/freight/freight_analysis/nat_freight_stats/docs/13factsfigures/index.htm

I-81 Corridor Coalition
Virginia Tech. Transportation Institute

Transportation Funding

- Shrinking fuel tax base
  - Vehicle efficiency
  - Electrification
- General funds used for highway trust fund?
- Vehicle Miles Traveled usage-based fees
  - Require tracking
  - Likely to incite heavy users
- Significant expansion unlikely

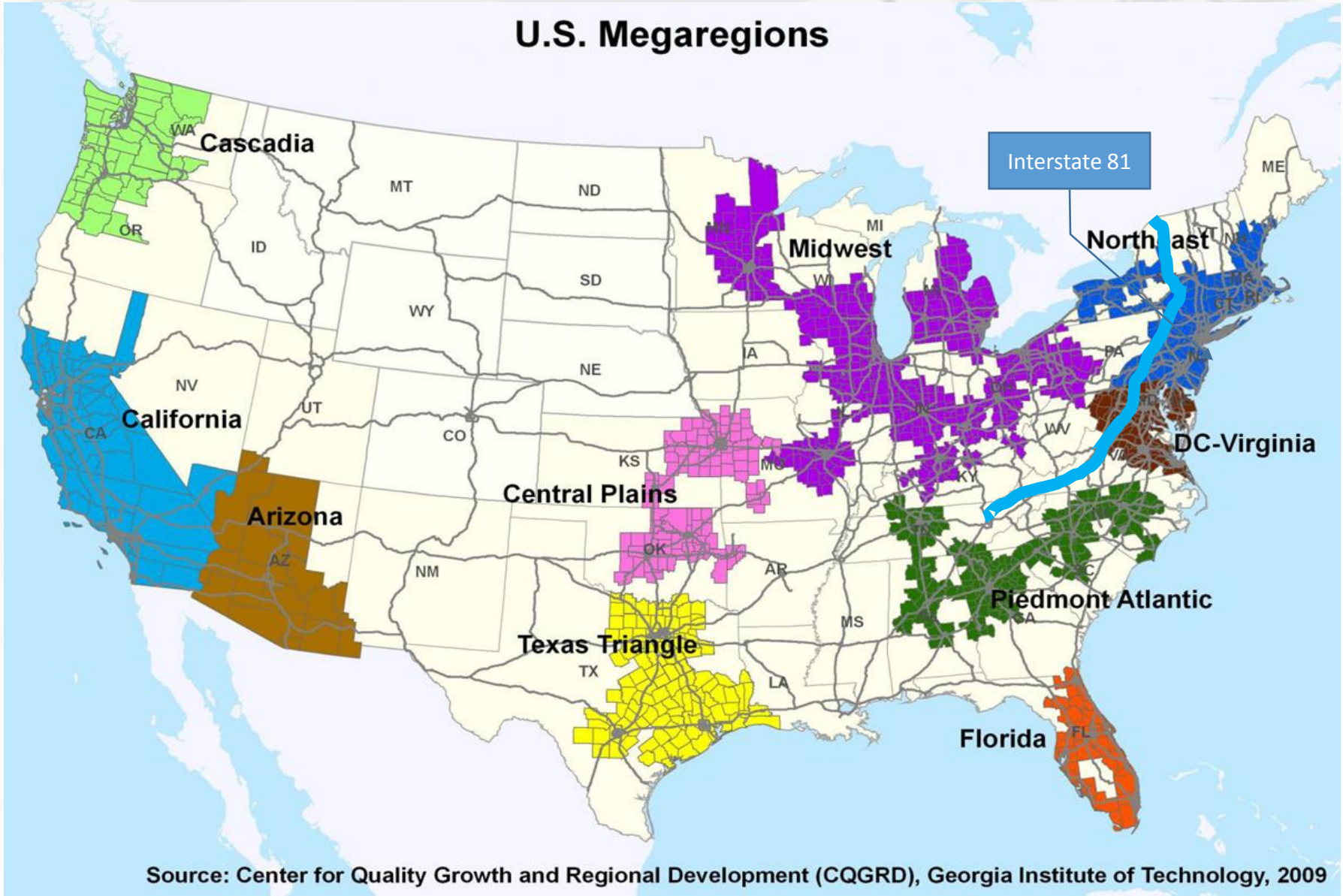


The I-81 Corridor

- Six states
- Extends from I-40 in TN to the Canadian Border in NY
- Appalachian track
- Relatively rural
- Diverse weather
- Varying topography

State	mile	km
TN	75.66	121.76
VA	324.92	522.91
WV	26.00	41.84
MD	12.08	19.44
PA	232.63	374.38
NY	183.60	295.48
Total	854.89	1,375.81

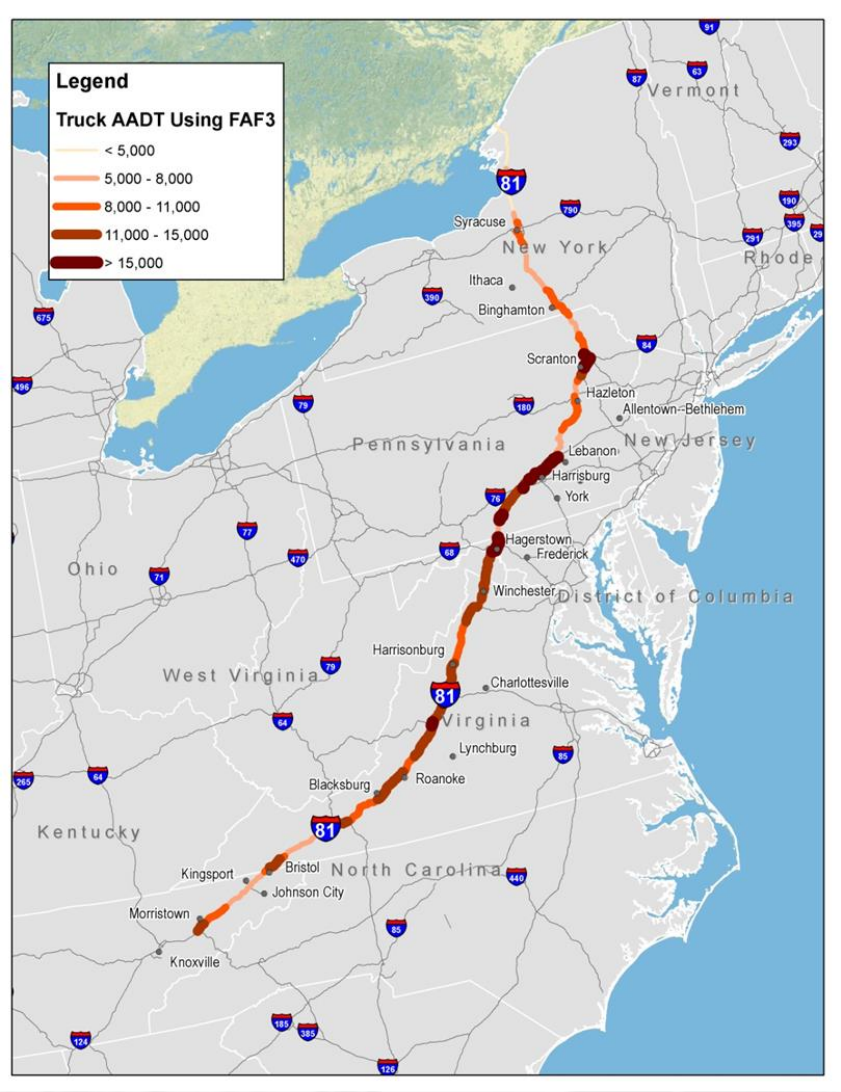
Interstate-81 Services Key Megaregions



Source: Center for Quality Growth and Regional Development (CQGRD), Georgia Institute of Technology, 2009

The I-81 Corridor - Freight

- Primary north-south freight corridor along the eastern part of the U.S.
- 38% of total volume - designed for 15% truck volume
- Freight traffic growth exceeds the national average
- Panamax traffic through eastern seaboard ports
- New, large manufacturing and distribution centers



Crash Incidents

Cumberland Co. officials, PennDOT mulling costs of proposed I-81 barriers

by CBS 21 Web Staff | Tuesday, April 26th 2016

The Cumberlar

Fiery wreck hurts two after lumber truck blows tire on I-81 North in Montgomery County

Three injured in I-81 crossover crash near Carlisle Sunday

Joshua Vaughn The Sentinel Mar 27, 2017 3

Tractor-trailer crash shuts down all lanes of I-81 near Chambersburg

Nov 24, 2016

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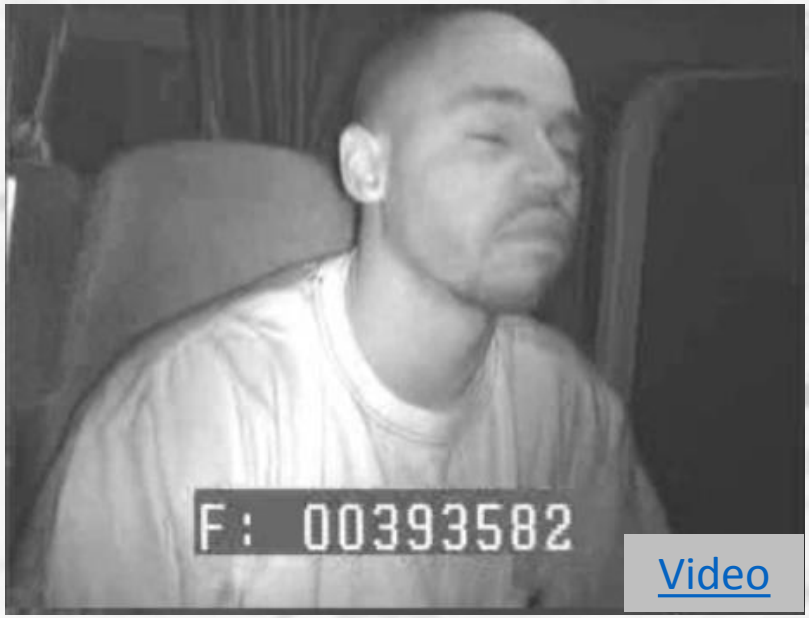
Truck Crash Causation

- Driver drowsiness
- Driver distraction
- Equipment failure
- Light vehicle drivers
- Curve rollovers
- Shifting loads

Video



Video

Video

Crash Impacts

- Loss of one lane of two reduces overall capacity by 65%
- Crash incidents account for ~25% of congestion nationwide
- 30 crashes/year with clearance times greater than 6 hours (VA)
- 35% fatal crashes involve trucks (not over-represented)
- 22% of non-fatal crashes involve trucks

The Economic Costs of Crash Congestion

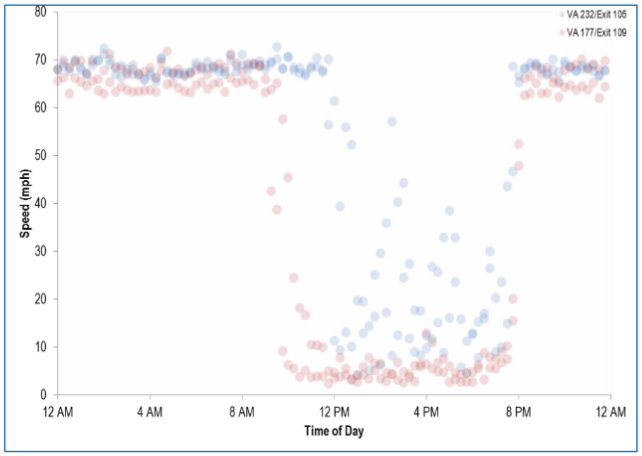
"When employees cannot get to work our lines do not run!!! – Cost Impact $700/min or $42,000 per hour"

"When our components do not make it to vehicle assembly plants!!! – Cost Impact $1,500/min or $90,000 per hour"

Impact of Incidents

I-81 Example Crash

- Incident involving tractor-trailer
- Duration: 12 hours
- Est. queue length: 8 miles
- Vehicle hours of delay: 16,355
- Est. delay cost: $612,000



Source: Center for Advanced Transportation Technology- Regional Integrated Transportation Information System (RITIS)

Why Automate Freight?

- Commercial driver shortage
- Efficiency
- Reduced congestion (highway, city)
- Better use of existing infrastructure
- Safety!

Why Automation? – Safety

Humans can be great drivers

An alert, attentive, sober driver is very good at avoiding crashes

Farber & Paley (1993) modeled driving behavior and found that an average U.S. driver will make approximately 3 million successful braking maneuvers with one failure during 25 years of driving

~94% of crashes result from human error

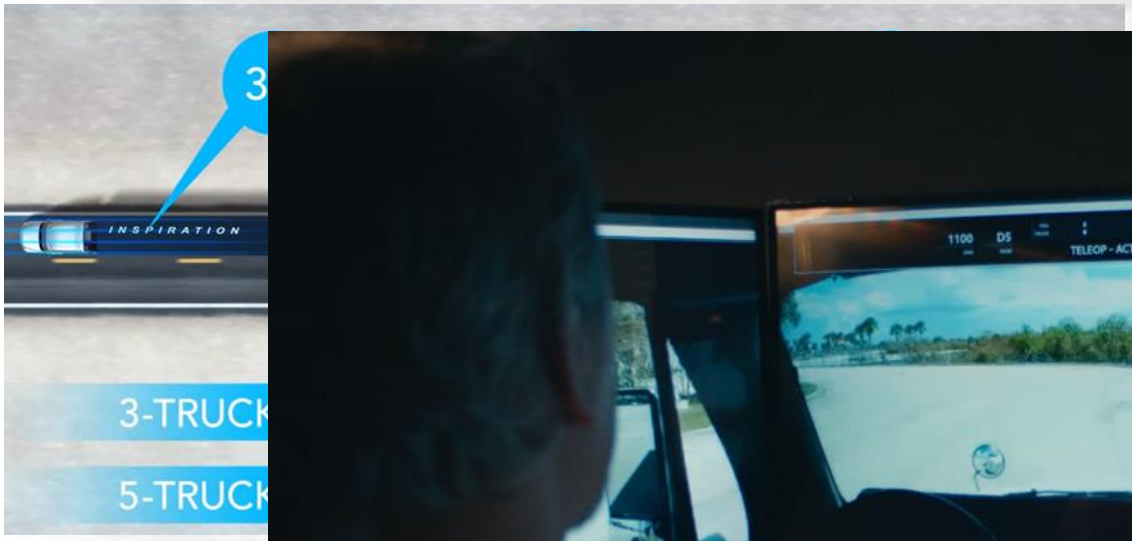
Machines don't get:

- Distracted
- Fatigued
- Drowsy
- High
- Mad

Freight Automation Applications

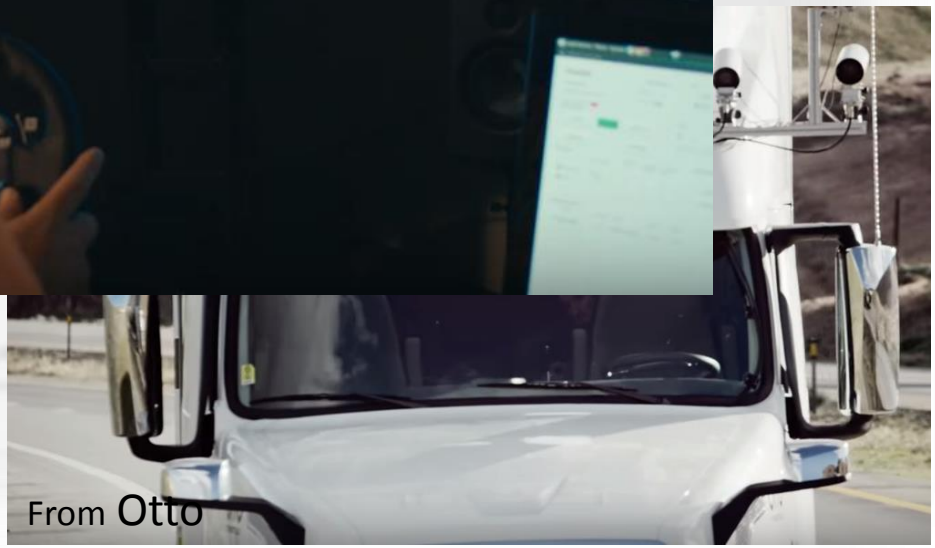
Ports & Intermodal (Drayage)

Highway



Images from Freig

From Starsky.io



From Otto

Urban Freight Automation

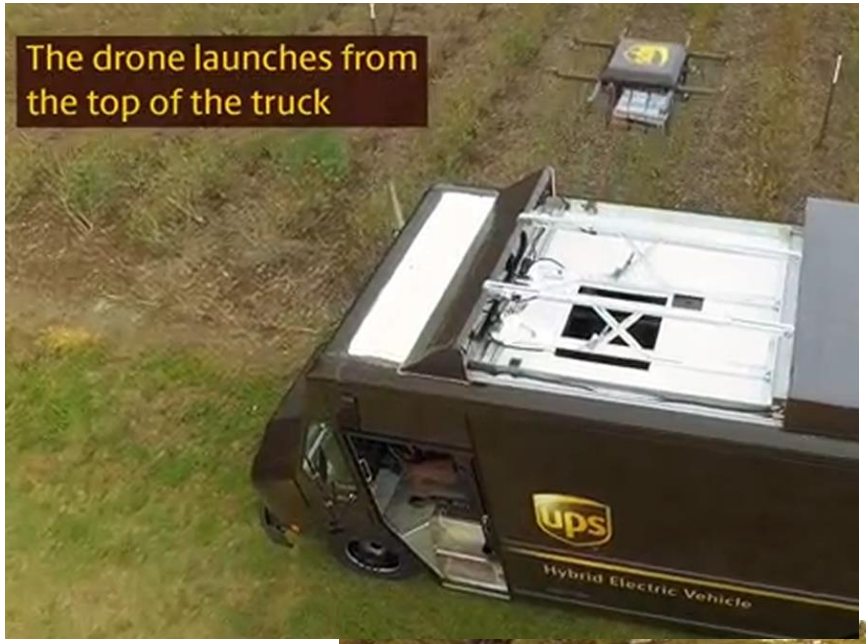
Unmanned Aerial Vehicles (UAV)

Unmanned Aerial Vehicle (UAV) – Primary Uses

- Physical presence/deterrents (e.g., clearing wildlife from runways)
- Transport
  - Goods
  - Weapons
  - Materials (e.g., pesticides)
  - People

- Elevated and mobile platforms
  - Remote sensing - observation
  - System host (e.g., cellular communication nodes, DSRC)

Going Airborne – UAV Freight



Images from UPS

UAV Transport of Time-Critical Deliveries

- Automatic External defibrillator
- Poison antivenin

Images from Alec Momont

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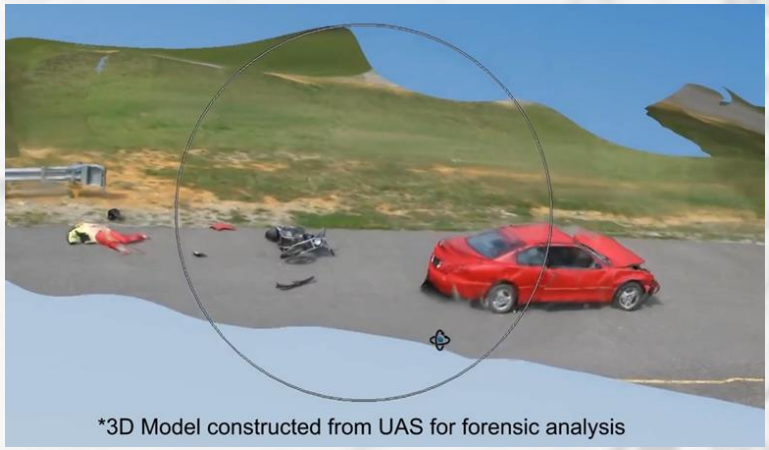
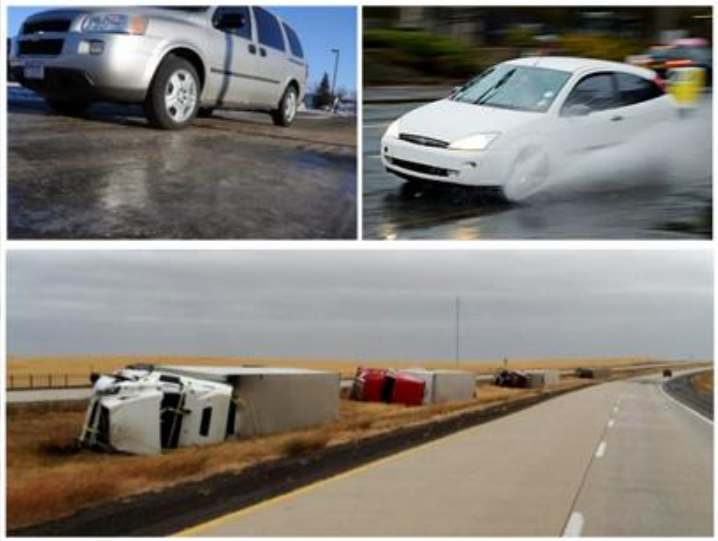
UAV Incident Response

- Expedited incident assessment
- Informed response
- Response prioritization
- Crash site reconstruction



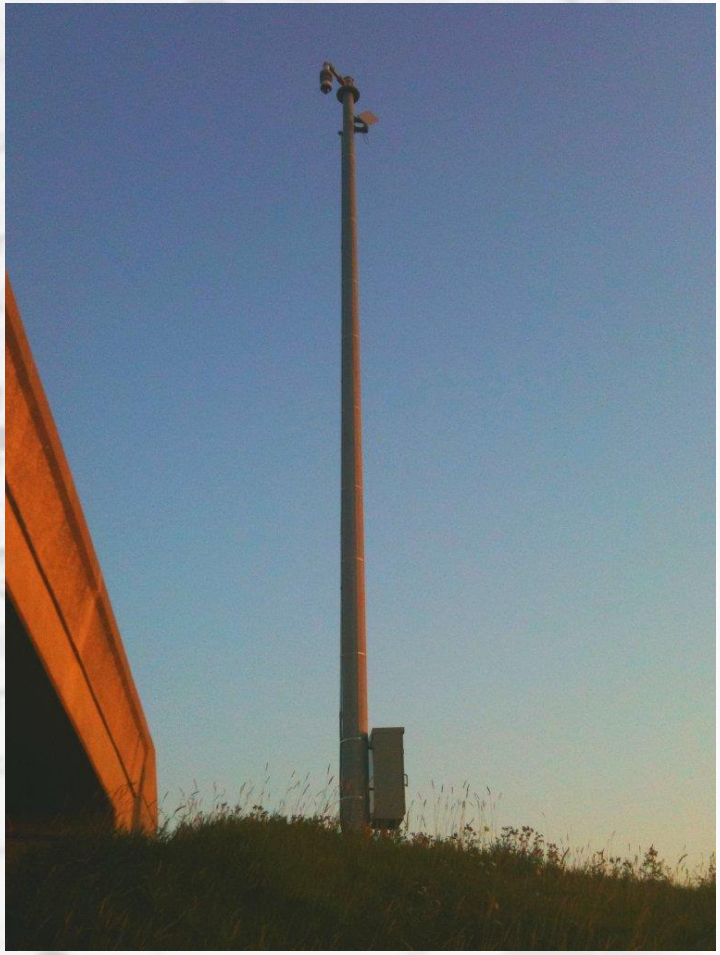
UAV Identification of traffic hazards

- Traffic volume, flow (machine vision)
- System management
- Road/rail weather hazard ID (ice, snow, puddling)

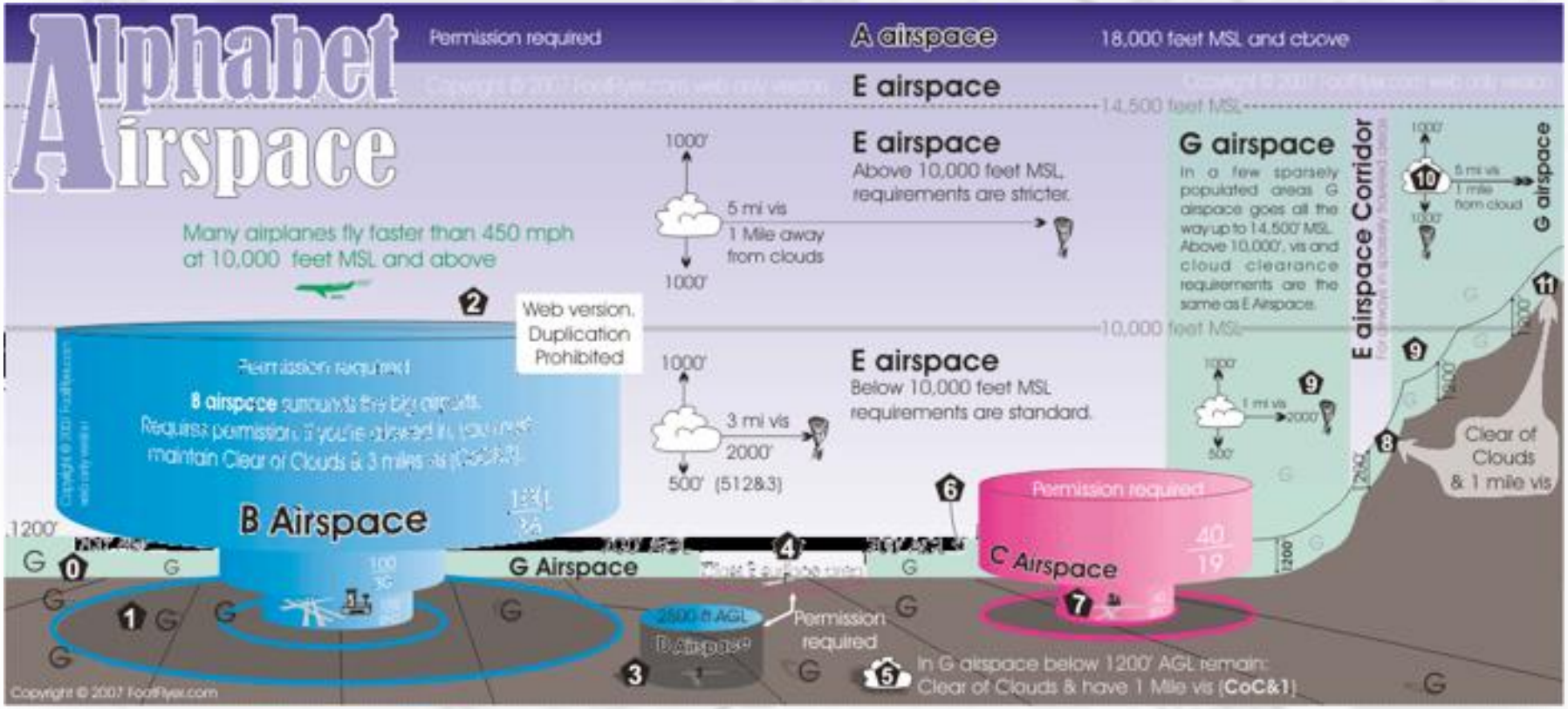


Deployment of UAVs from remote platforms for incident surveillance

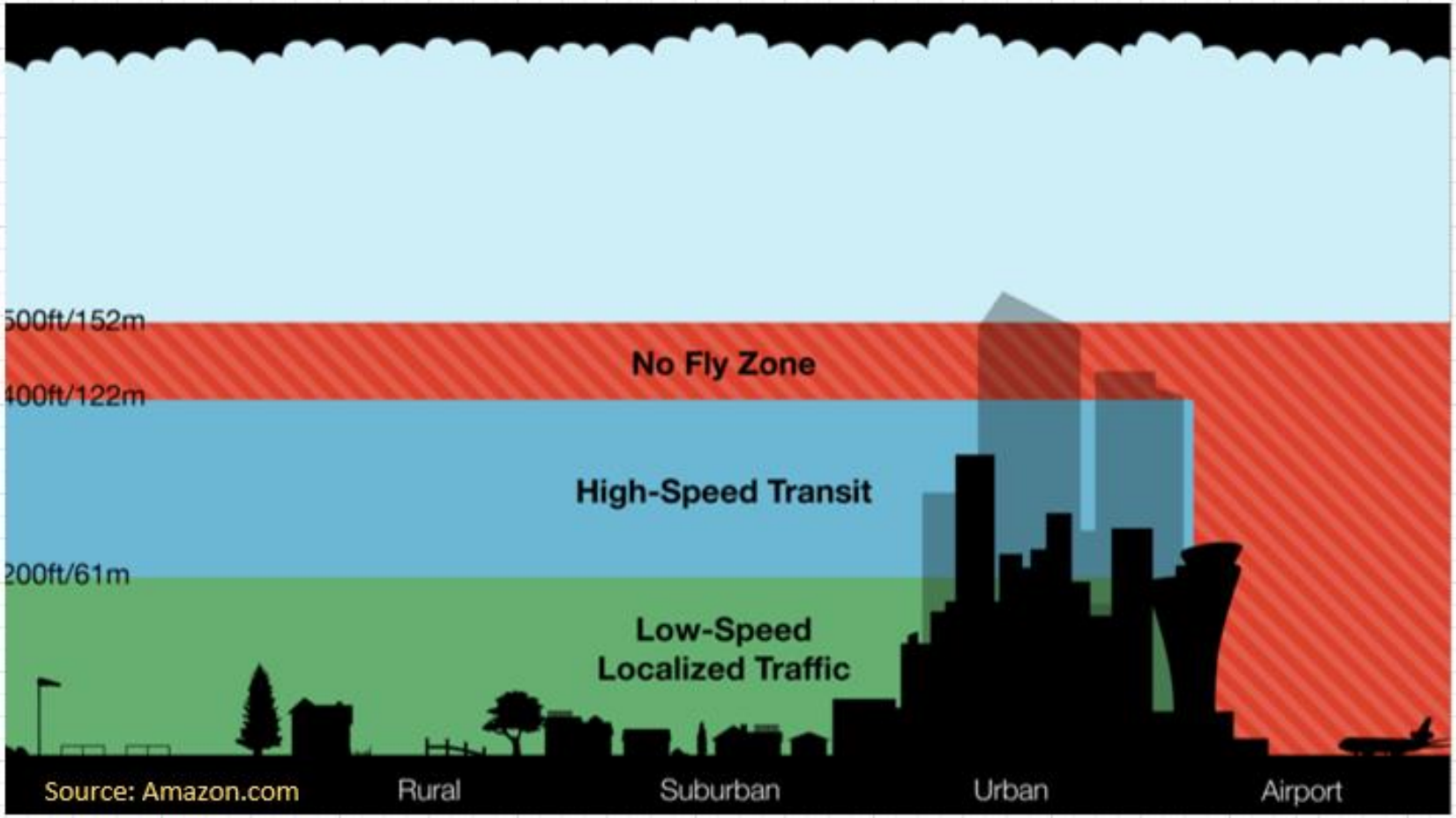
- UAVs “roosted” at geographically distributed locations
- Automated and/or piloted remotely
- Acquired data streamed to TOC
- Existing camera towers or other locations provide:
  - Power for battery recharging
  - Secure perch
  - Data link -- data type determines transmission mode (cellular, RF, fiber, etc.)



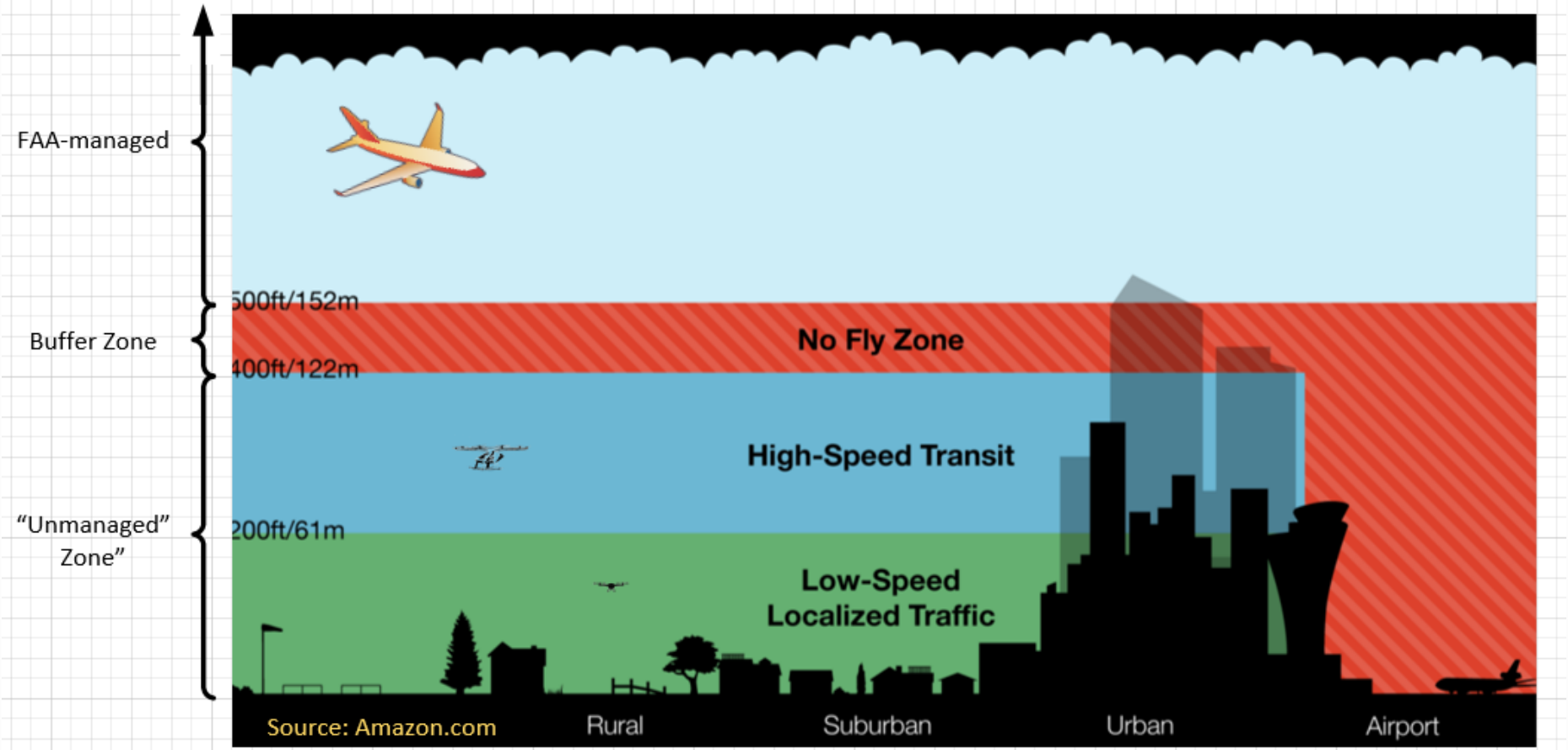
Airspace Management - FAA



Proposed Airspace Apportionment



Mixed-Domain Management Model – Which DOT?



Presentation End

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