Fletcher, Heald & Hildreth

1300 NORTH 17th STREET, 11th FLOOR
ARLINGTON, VIRGINIA 22209

OFFICE: (703) 812-0400
FAX: (703) 812-0486
www.fhhlaw.com
www.commlawblog.com

CHENG-YI LIU
(703) 812-0478
liu@fhhlaw.com

March 30, 2018

Via Electronic Filing

Ms. Marlene H. Dortch, Secretary
Federal Communications Commission
445 12th Street SW
Washington DC 20554

Re: GN Docket No. 17-183, *Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz*
Notice of *Ex Parte* Communication

Dear Ms. Dortch:

On behalf of the Fixed Wireless Communications Coalition (FWCC), pursuant to Section 1.1206(b) of the Commission's Rules, I am electronically filing this notice of an *ex parte* presentation in the above-referenced docket.

On Thursday, March 29, 2018, representatives of the FWCC met with Commission representatives from the Office of Engineering and Technology, Wireless Telecommunications Bureau, and International Bureau to discuss the points summarized in the attached handouts, which reflect the views previously set out in the FWCC's pleadings in the above-referenced docket. A list of the meeting participants is also attached.

Respectfully submitted,

Cheng-yi Liu
Counsel for the Fixed Wireless
Communications Coalition

Attachments

cc: Meeting participants (*via email*)
Paul Margie, Counsel to Apple Inc., Broadcom Corporation, Facebook, Inc., Hewlett Packard Enterprise, and Microsoft Corporation (*via email*)

MEETING PARTICIPANTS

<u>FWCC</u>

George Kizer, FWCC representative
Mitchell Lazarus, Fletcher, Heald & Hildreth, PLC
Cheng-yi Liu, Fletcher, Heald & Hildreth, PLC

<u>Federal Communications Commission</u>

Michael Ha (OET)
Bahman Badipour (OET)
Brian Butler (OET)
Aole Wilkins El (OET)
Karen Rackley (OET)
Jamison Prime (OET)
Donald Stockdale (OET)
Julius Knapp (OET)
Nicholas Oros (OET)
Paul Murray (OET)

Christopher Bair (IB)
Diane Garfield (IB)
Jose Albuquerque (IB)

Stephen Buenzow* (WTB)
Rebecca Schwartz* (WTB)
Dana Shaffer* (WTB)
Thomas Derenge* (WTB)
Peter Daronco * (WTB)
Matthew Pearl * (WTB)

* participated telephonically

Expanding Flexible Use in Mid-Band Spectrum
GN Docket No. 17-183

Fixed Wireless Communications Coalition

March 29, 2018

About the FWCC

- Companies, associations, individuals interested in terrestrial fixed microwave
- Formed in 1998, speaks for the fixed service community
- Active in 70+ FCC proceedings plus NTIA, FAA, GAO, courts
- Membership includes:
  - microwave equipment manufacturers
  - fixed microwave engineering / frequency coordination firms
  - licensees of fixed microwave systems (and/or associations)
  - communications service providers (and/or associations)
  - major users (railroads, utilities, petroleum/pipeline, public safety) and/or ass'ns
  - backhaul providers, communications carriers
  - telecommunications attorneys and engineers.

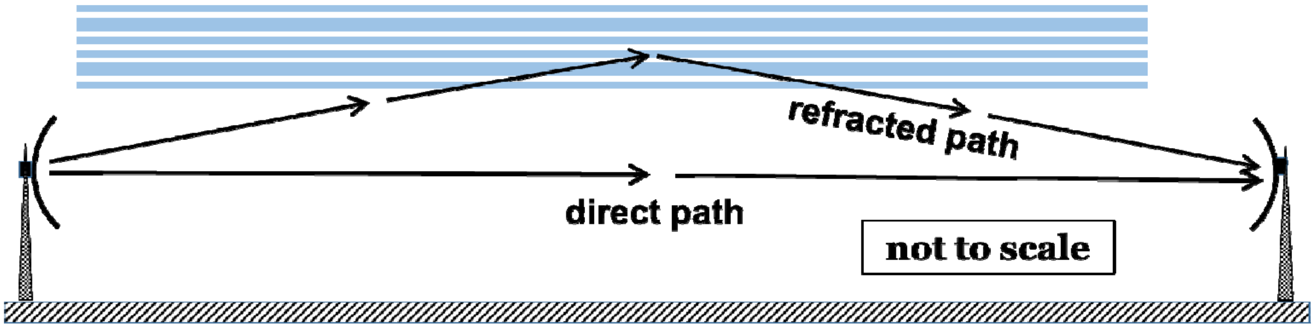
About 6 GHz Fixed Microwave

- 95,000+ U.S. links
- Carries time-critical services, including:
  - synchronizing railroad trains
  - control of petroleum and natural gas pipelines
  - maintaining balance in the electric grid
  - backhaul to dispatch public safety and emergency vehicles

- Achieves high reliability:
  - safety-related links: 99.9999% (30 seconds outage per year)
  - most others: 99.999% (five minutes outage per year)
- 6 GHz is the only band available for links that must span tens of miles.

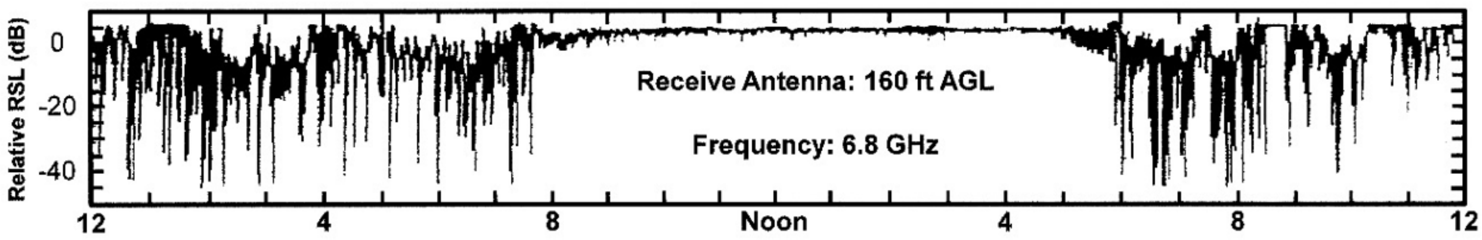
Microwave Fading – 1

- All fading at 6 GHz is multipath:
  - refraction from the atmosphere creates a longer signal path
  - direct and refracted signals partially cancel at receiver
    - lowers received signal by 0-40 dB
    - received signal level fluctuates.



Microwave Fading – 2

- Multi-path fading is a nighttime phenomenon
- Without precautions, fading would cause frequent outages.



Need for Fade Margin

- Fade margin is reserve power that allows communication to continue through fades
  - typically 25-40 dB
- Higher-reliability links require greater fade margin
- Even a brief outage to one link can be catastrophic:
  - all networked links in a system go down for several minutes while the system resynchronizes
- High fade margin is expensive
  - but necessary for maintaining critical communications.

Interference and Fade Margin

- Interference cuts into available fade margin
- Moderate interference (fade margin reduced **1-20 dB**):
  - link may operate, but vulnerable to outage from fades
  - if system is in fade condition, interference may cause errors or outage
- Severe interference (fade margin reduced **> 30 dB**):
  - leaves little or no fade margin
  - causes errors in transmission
- Disabling interference (fade margin reduced **> 40 dB**):
  - uses up all fade margin
  - shuts down most links.

FWCC Simulation: Assumptions from RKF

- Key assumptions taken from the RKF study:
  1. 958M total RLANs in use (RKF page 13)
  2. RLANs concentrated in urban/suburban 5% of U.S. land area (RKF page 16)
  3. 0.6% of RLANs located outdoors (RKF page 13)
     (*note*: assumptions 1-3 predict 15.1 outdoor RLANs per square kilometer)
  4. RLANs operate at 35 dBm (RKF page 18)
  5. Ignore RLANs within 30 meters of microwave receive antenna (RKF page 33).

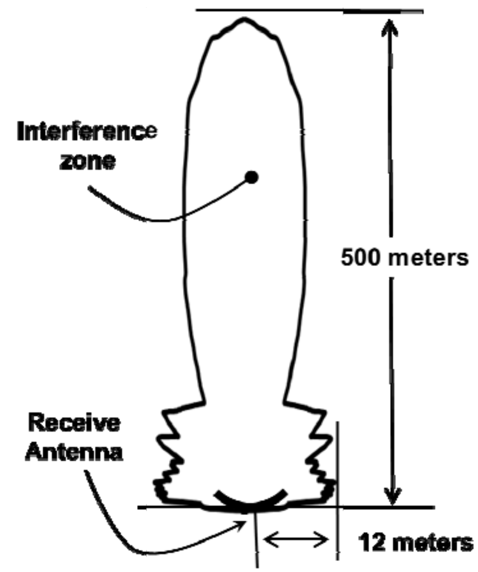
FWCC Simulation: Additional Assumptions

- Further FWCC assumptions that *reduce* predicted interference:
  - consider only outdoor RLANs (as if building walls shield perfectly)
  - all RLANs near ground level
  - reduced antenna gain for RLANs in the receive antenna near field
  - only one RLAN operating at a time (no aggregate interference)
  - WINNER II Urban path loss model for all interference paths (more conservative than RKF's models).

FWCC Simulation: Method

1. Calculate the zones in front of a microwave receive antenna where a 35 dBm RLAN will reduce fade margin by specified degrees
   - determine for fade margin reductions of 1 dB, 10 dB, 20 dB, 25 dB, 30 dB, 40 dB
   - determine for antenna sizes of 3, 4, 6, 8, 10, 12 feet

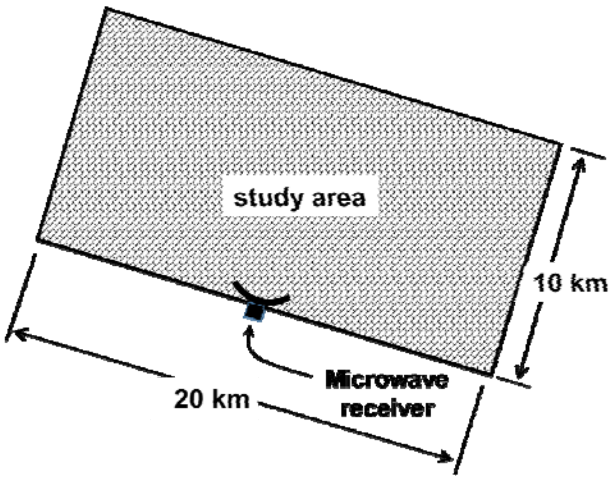
     (RKF did not consider antenna size – an important determinant of susceptibility to interference)



Example: zone for 6-foot antenna where an RLAN reduces fade margin by 30 dB (horizontal scale magnified)

FWCC Simulation: Method (cont'd)

2. Draw a 193 km square centered on each of eight cities (not shown)
3. Within each square, identify all 5925-6425 MHz microwave receivers that use 30 MHz bandwidth (total of 7,596 receivers)
4. For each microwave receiver and antenna, draw a 20 x 10 km study area (as shown)
5. Randomly distribute RLANs in the study area at a density of 15.1 units per square kilometer
6. For each receiver and antenna, count the RLANs that fall within its interference zones for specified levels of interference
7. Repeat 1,000 times for each antenna size; average the results.



FWCC Simulation: Summary of Results

Fade Margin Reduction Due to RLANs	**Fraction of Microwave Receivers Affected**	**Likely Consequence**
≥ 2 dB	all	(see note below)
≥ 10 dB	7/10	vulnerable to ordinary fades
≥ 20 dB	1/3	
≥ 30 dB	1/9	bit errors occur
≥ 40 dB	1/33	link fails

≥ 2 dB exceeds RKF's own interference criterion of 1 dB*, and is unacceptable under normal frequency coordination procedures.

* RKF's comparison threshold is a -6 dB ratio of interference level to receiver front end noise (page 11), equivalent to 1 dB reduction in fade margin.

Shortcomings in RKF Study – 1

- Write-up makes it impossible to replicate calculations and confirm stated conclusions.

Shortcomings in RKF Study – 2

- Study neglected line-of-sight propagation*
  - assumed all paths have urban/suburban clutter, which ignores, *e.g.*:
    - RLAN and microwave receiver lined up along streets
      - AT&T study found long unobstructed paths
    - microwave receiver on mountaintop overlooking city on flat terrain
      - Phoenix, Albuquerque, San Francisco, etc.
  - **line-of-sight causes 40 dB of interference from 15 km away.**

* Although study claimed to consider both line-of-sight and non-line-of-sight (page 33), relevant curves (Figures 4-2 and 4-3) suggest only non-line-of-sight.

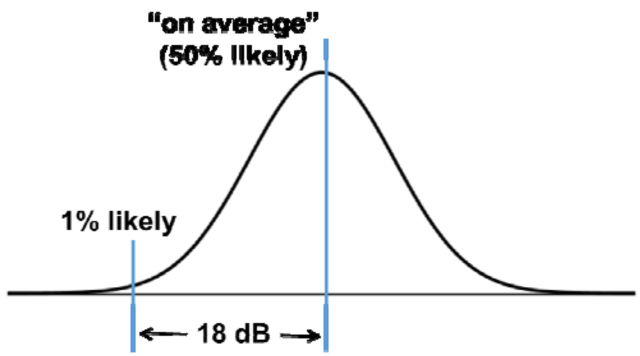
Shortcomings in RKF Study – 3

- Study ignored 95% of U.S. landmass as “barren areas”
  - long-haul 6 GHz links make interconnections at relay facilities in sparsely populated areas
  - little ground clutter to attenuate RLAN signals
  - even one RLAN kilometers away from a tower can have line of sight and take down a link.

Source: Carl Chapman Photography, with permission

Shortcomings in RKF Study – 4

- Wrong statistical standard: study predicted interference “on average”
  - misses the relatively infrequent cases most likely to cause interference
  - switching to 99% confidence level requires reducing RLAN power by 18 dB.



Shortcomings in RKF Study – 5

- Study may have co-opted receiver fade margin to explain away interference (write-up is not clear)
  - study said – incorrectly – that peak RLAN use (7-11 pm) and multipath fading occur at different times (multipath is sunset to sunrise)
  - RLAN proponents cannot properly rely on fade margin to absorb interference
  - even sparse RLAN use at night risks microwave outages.

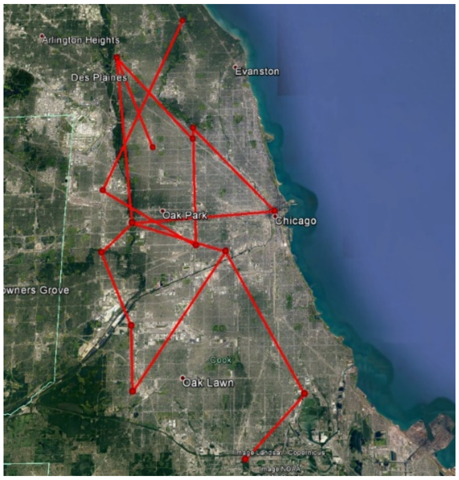
Conclusion

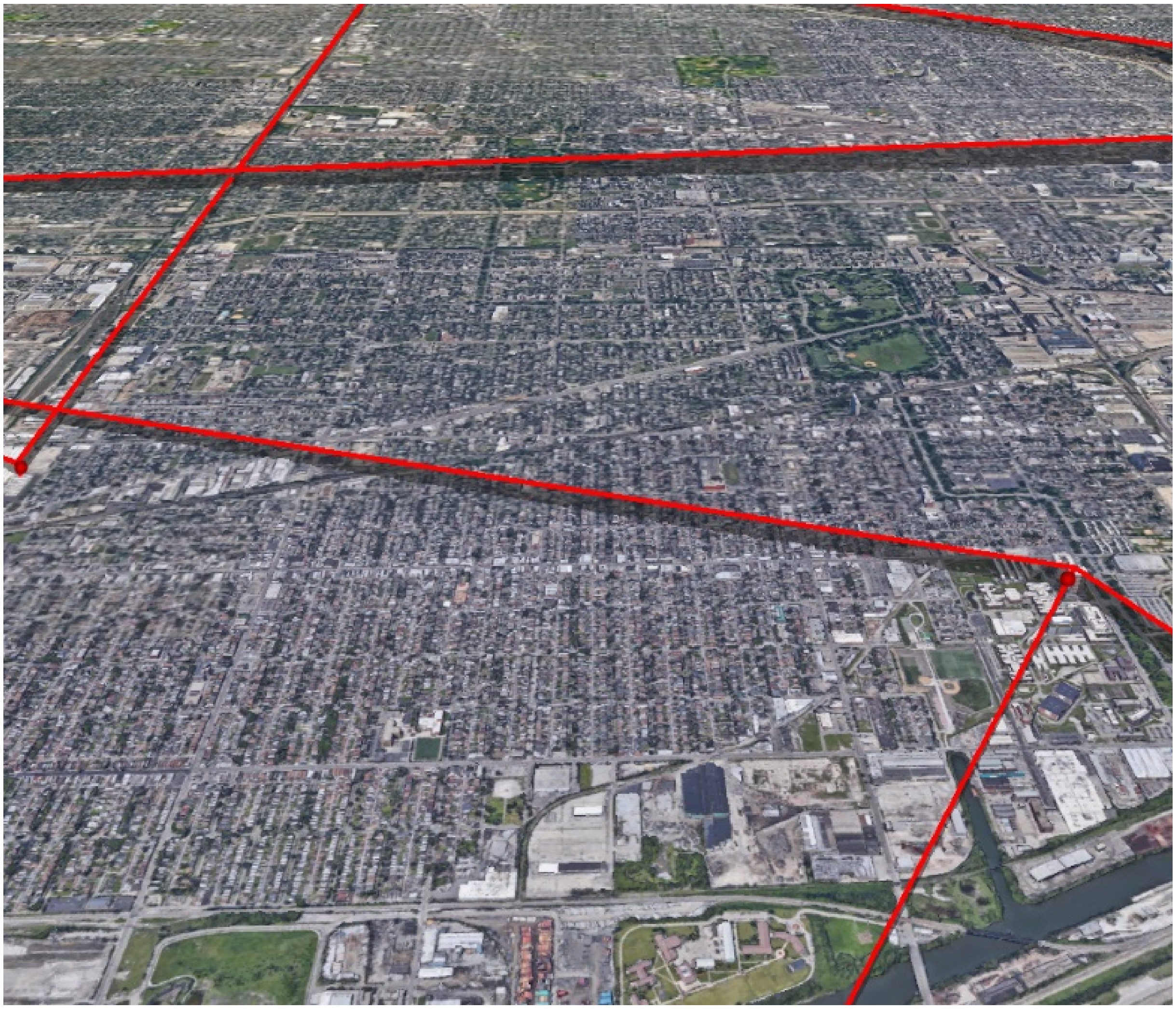
- Use of RLANs as described in the RFK study will cause widespread harmful interference to 6 GHz fixed links.

Thank you!

Cheng-yi Liu | 703-812-0478 | liu@fhhlaw.com
Mitchell Lazarus | 703-812-0440 | lazarus@fhhlaw.com
George Kizer | 972-333-0712 | georgekizer@gmail.com

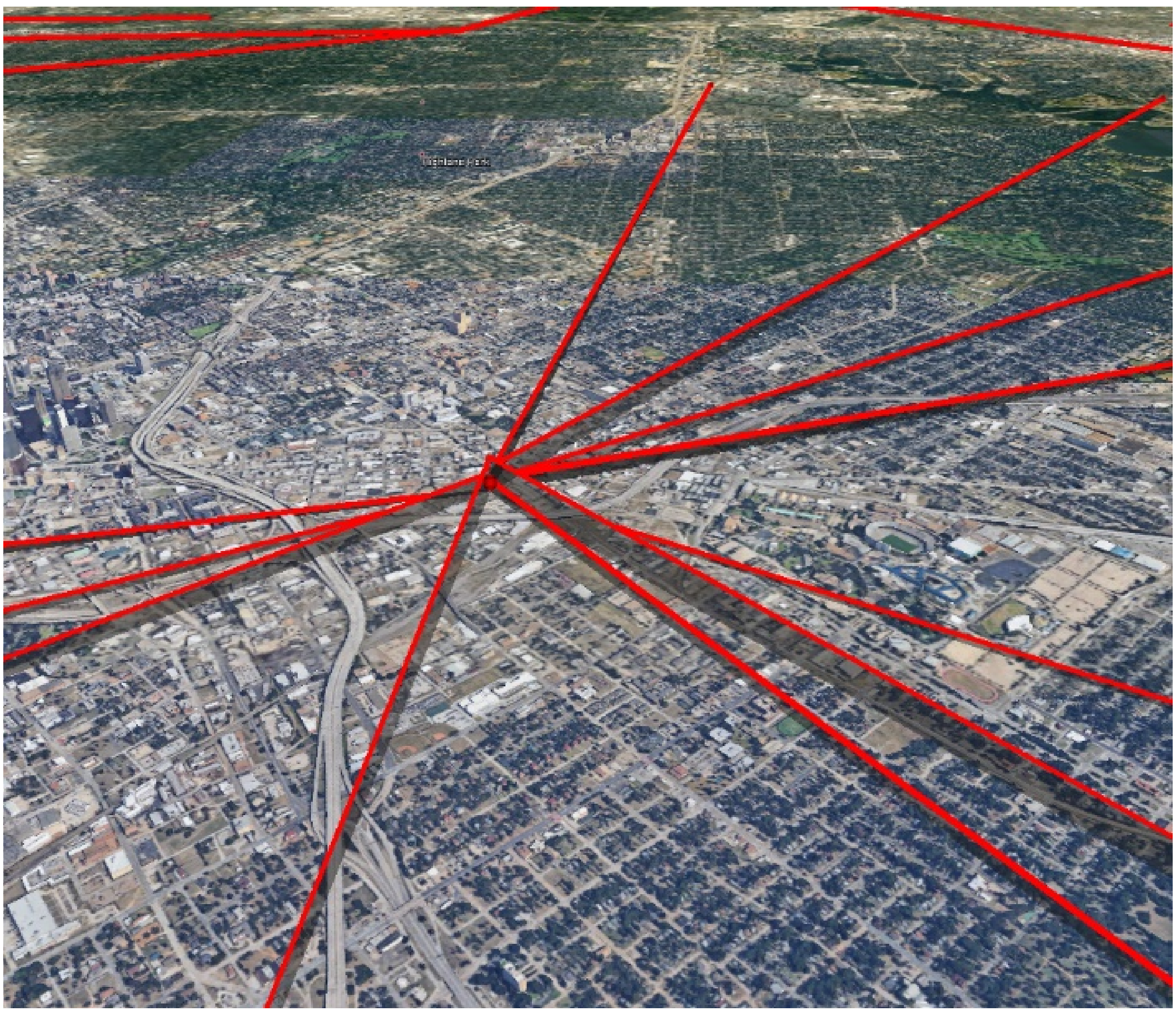
Examples of Urban Paths with Free Space Propagation to Potential Interference



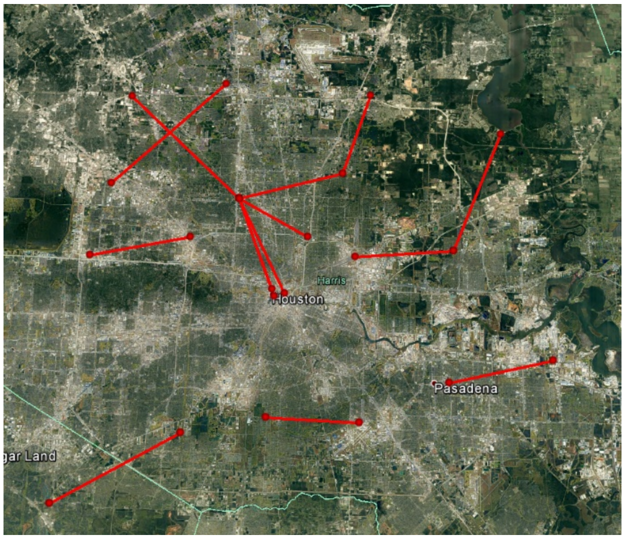


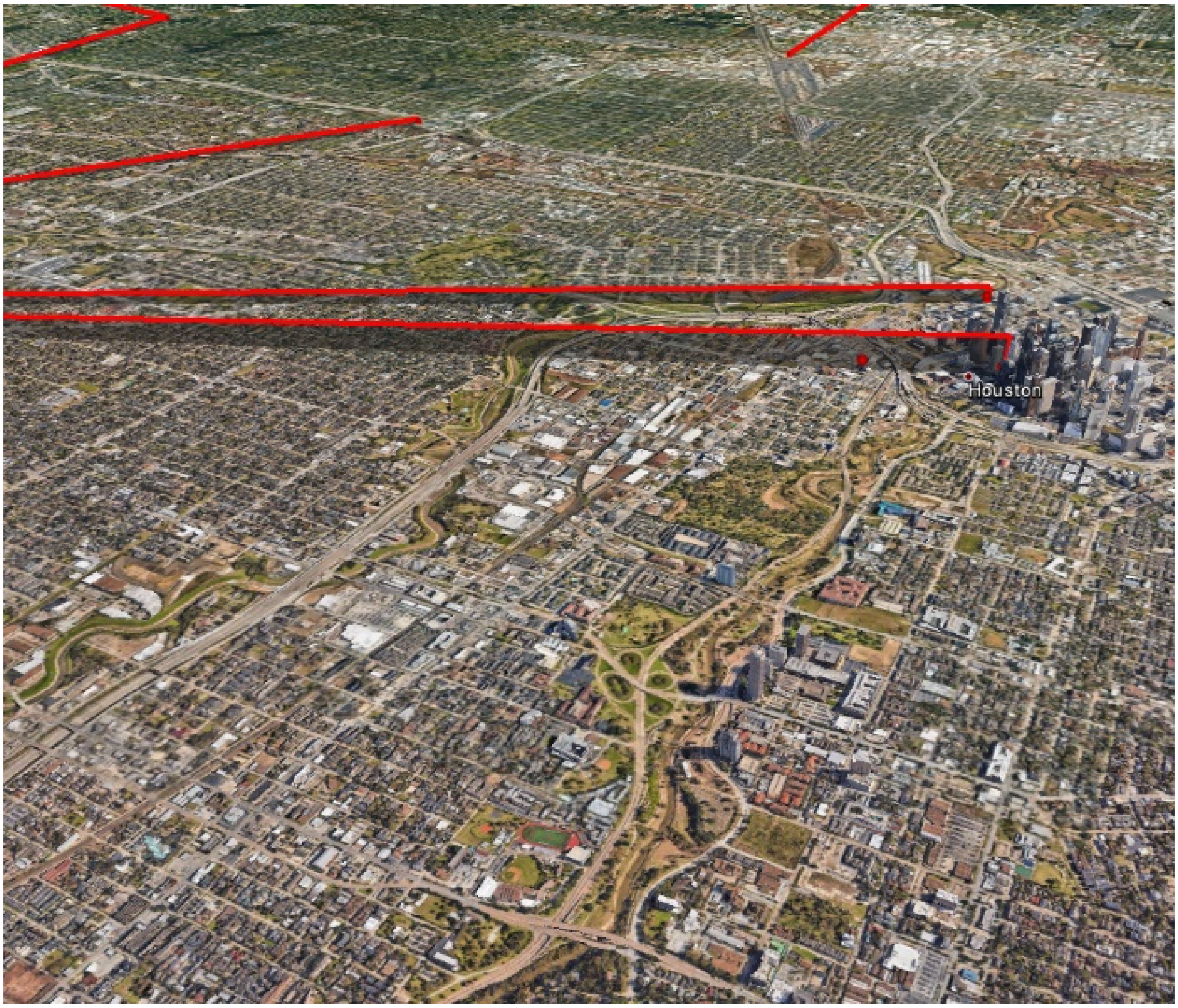
Chicago


Flower Mound
Plano
Carrollton
Grapevine
Richardson
Garland
Bedford
Irving
Dallas
Dallas
Arlington
Grand Prairie
Mesquite
Mansfield

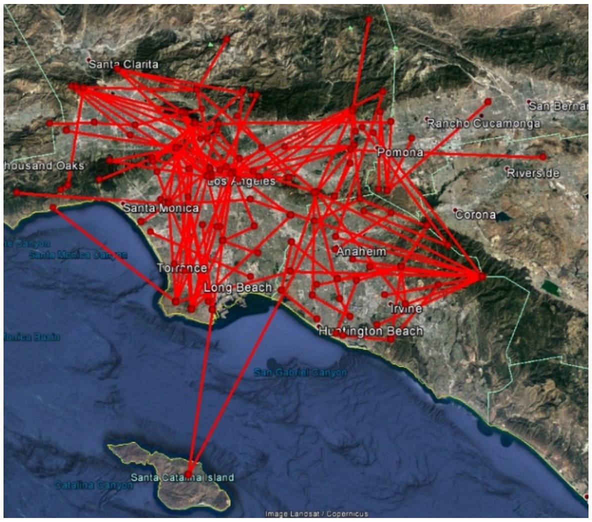


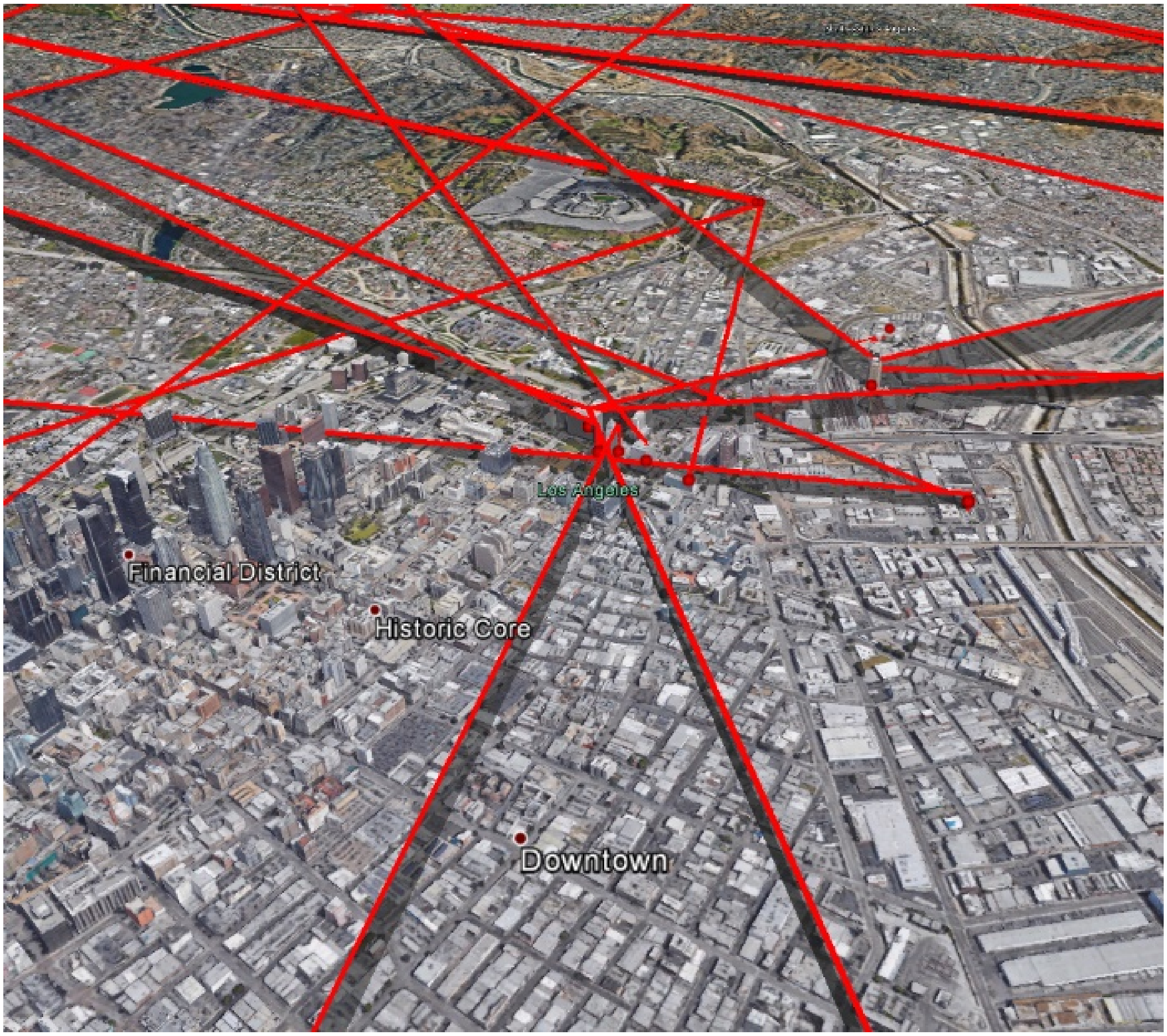
Dallas



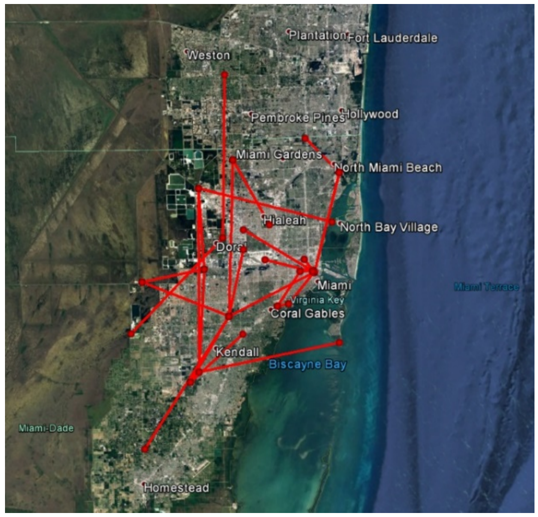


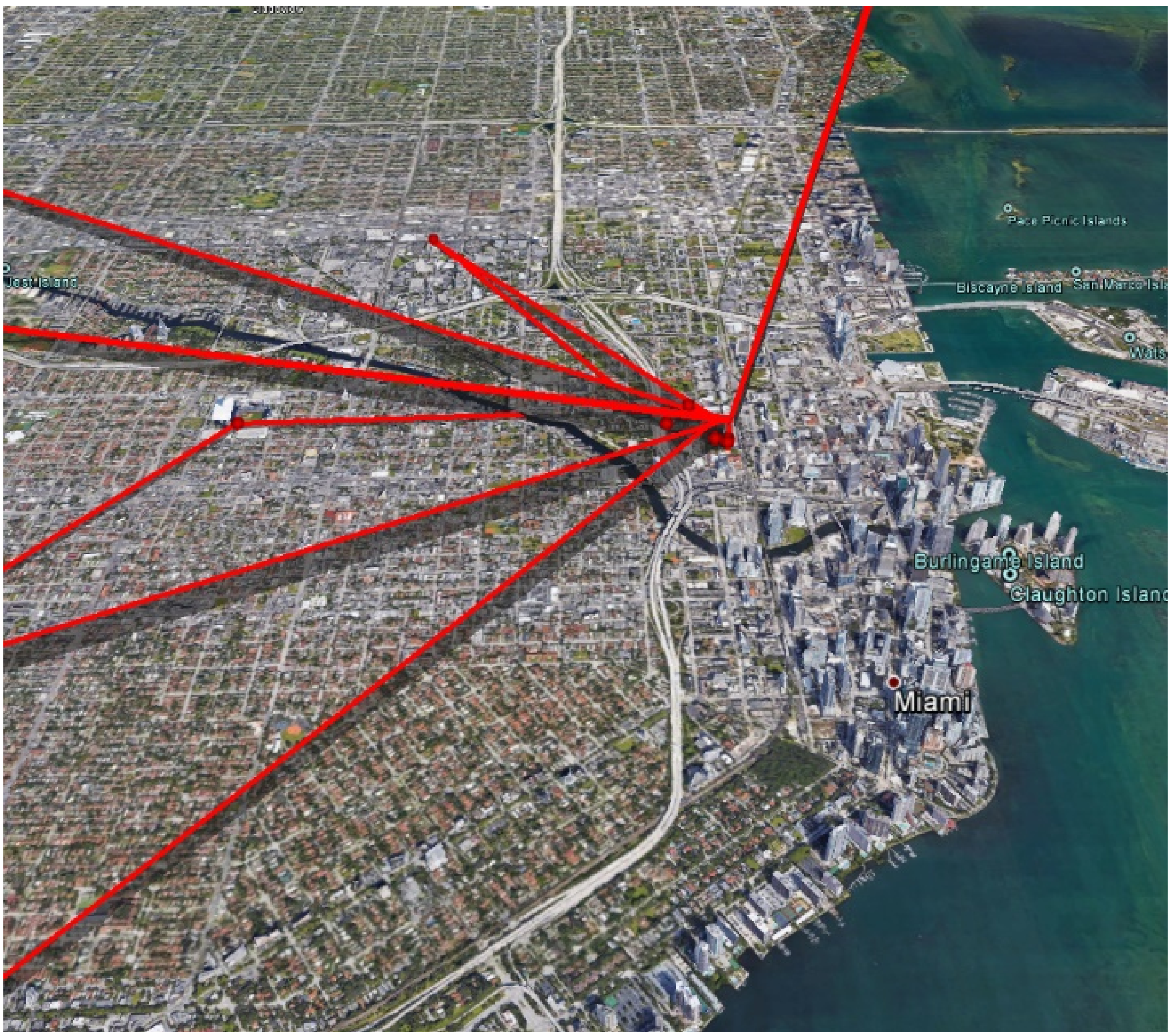
Houston


Santa Clarita
Rancho Cucamonga
Pomona
Thousand Oaks
Los Angeles
Riverside
Santa Monica
Corona
Anaheim
Torrance
Long Beach
Irvine
Huntington Beach
Santa Catalina Island

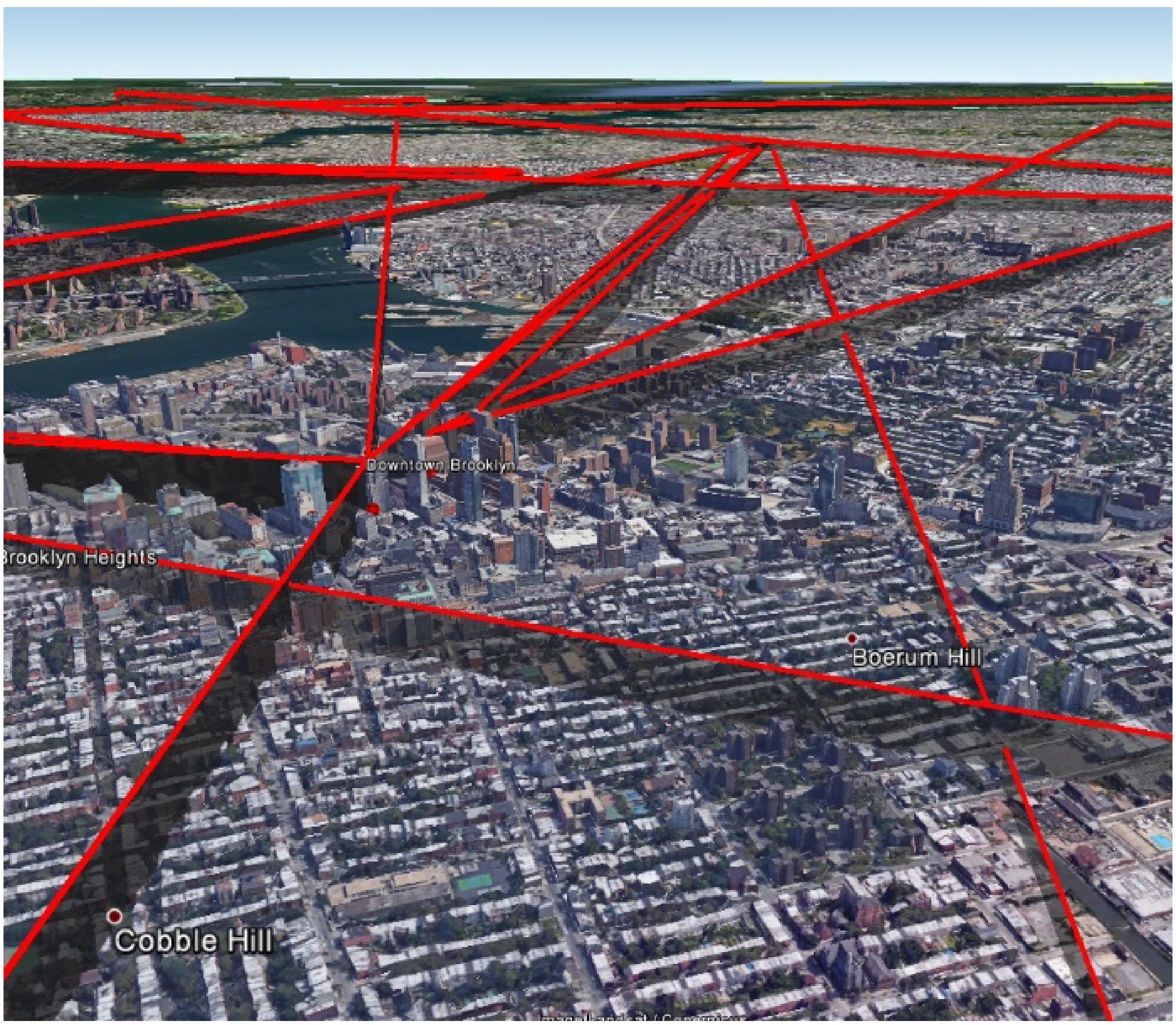

Los Angeles
Financial District
Historic Core
Downtown

Los Angeles

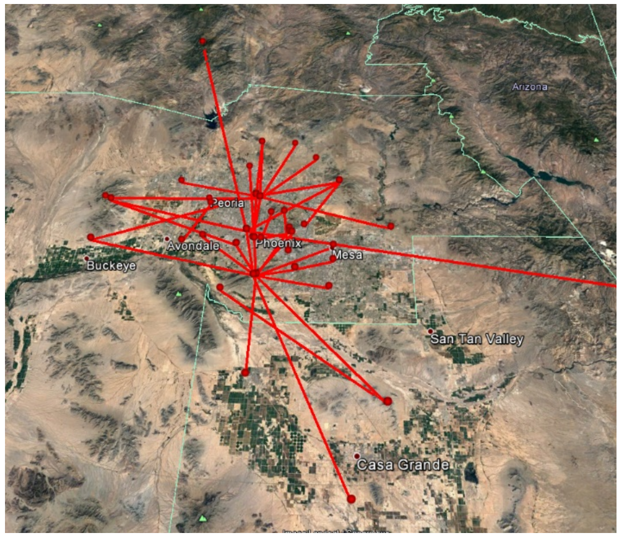

Plantation
Fort Lauderdale
Weston
Pembroke Pines
Hollywood
Miami Gardens
North Miami Beach
Hialeah
North Bay Village
Doral
Miami
Coral Gables
Kendall
Biscayne Bay
Homestead

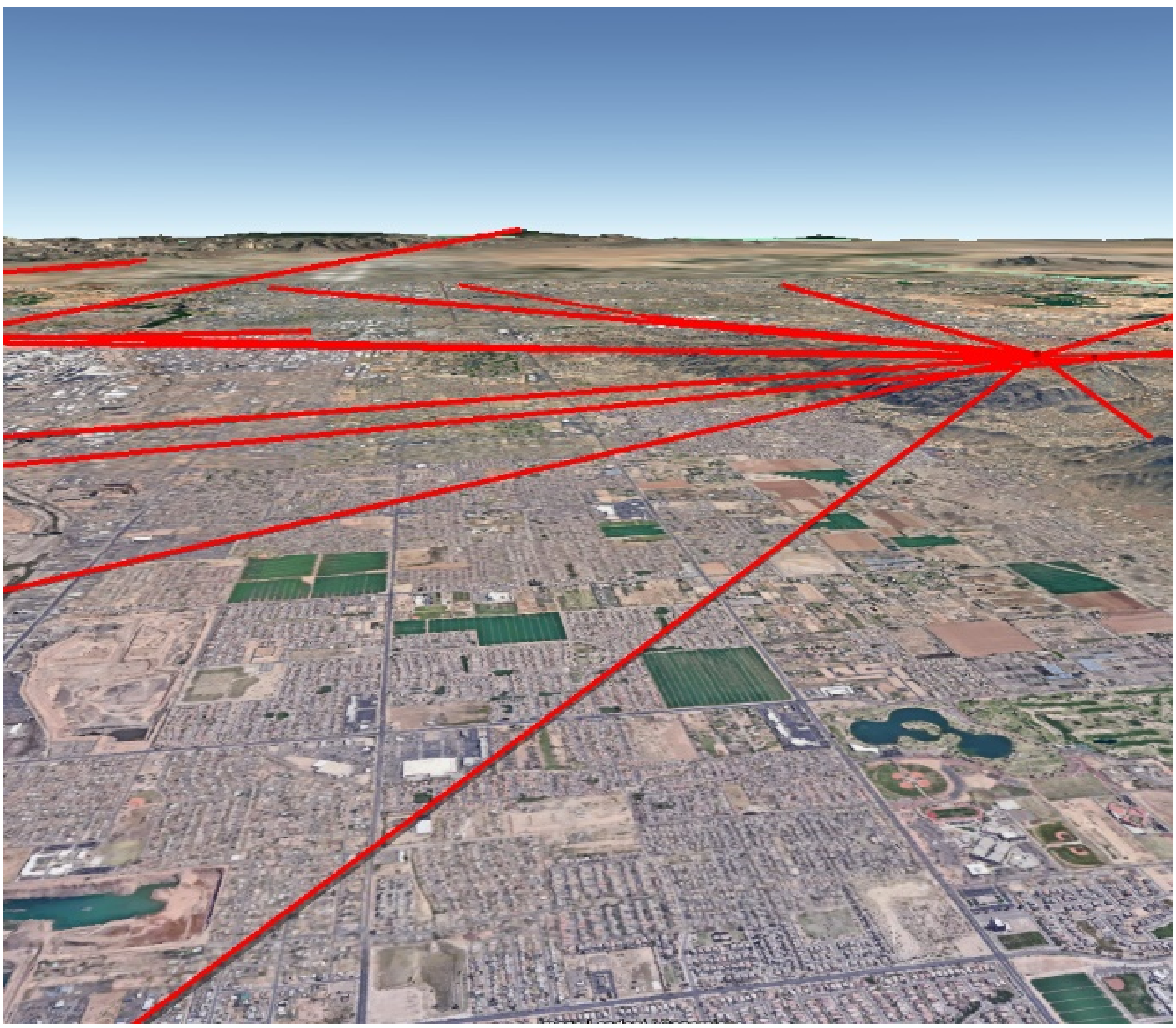

Pace Picnic Islands
Biscayne Island
Burlingame Island
Miami

Miami

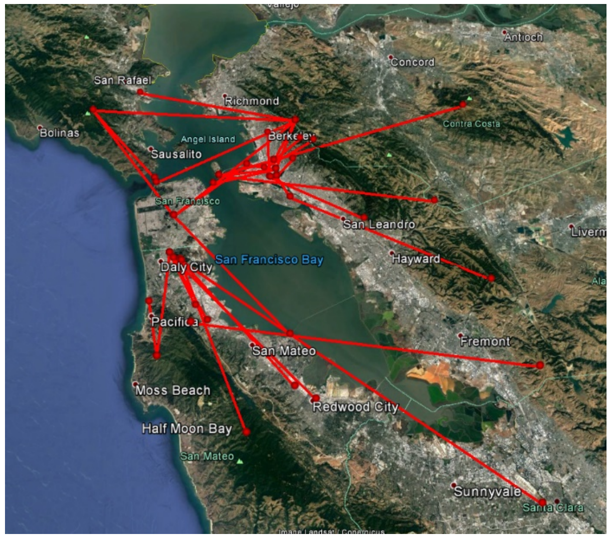


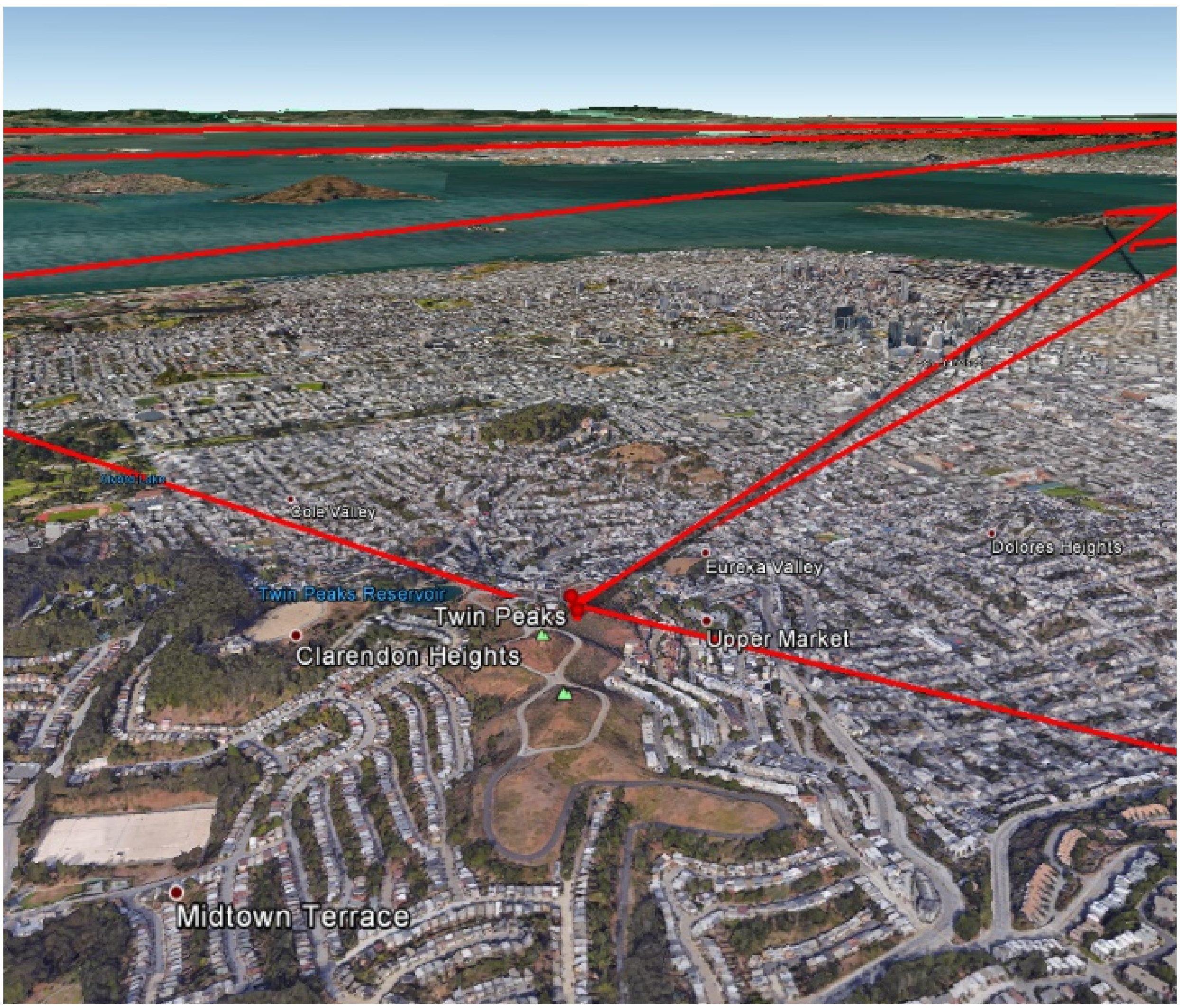
New York City


Arizona
Peoria
Avondale
Phoenix
Buckeye
Mesa
San Tan Valley
Casa Grande

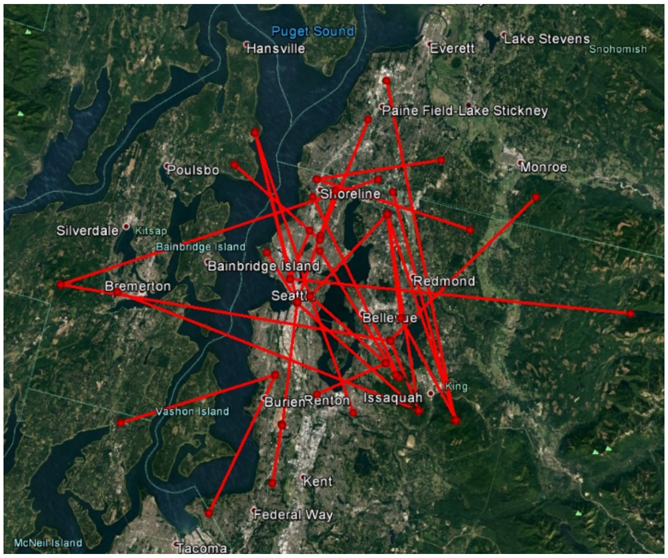


Phoenix





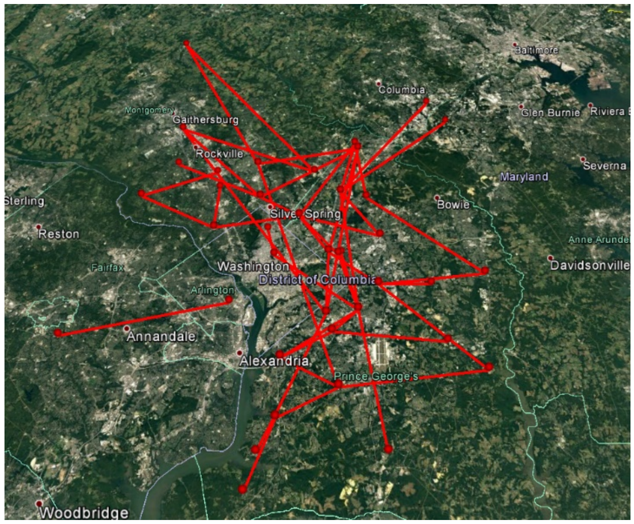
San Francisco



Puget Sound
Hansville
Everett
Lake Stevens
Snohomish
Paine Field-Lake Stickney
Poulsbo
Monroe
Shoreline
Silverdale
Kitsap
Bainbridge Island
Bainbridge Island
Bremerton
Redmond
Bellevue
Burien
Renton
Issaquah
King
Vashon Island
Kent
Federal Way
McNeil Island
Tacoma

Pike Place Market
Pike Pine Retail Core
Seattle Waterfront
Central Business District
Seattle
Pioneer Square
First Hill

Seattle



Washington DC