arpa.e digital transportation workshop

jason rugolo — program director

team:

justin manzo — technical contractor
geoff short — technical contractor
paul d'angio — technical contractor
mike kane — fellow

our theme for the day:

bits not atoms.

(or we will be miserable and doomed.)

171 flights

38 airports
10 carriers

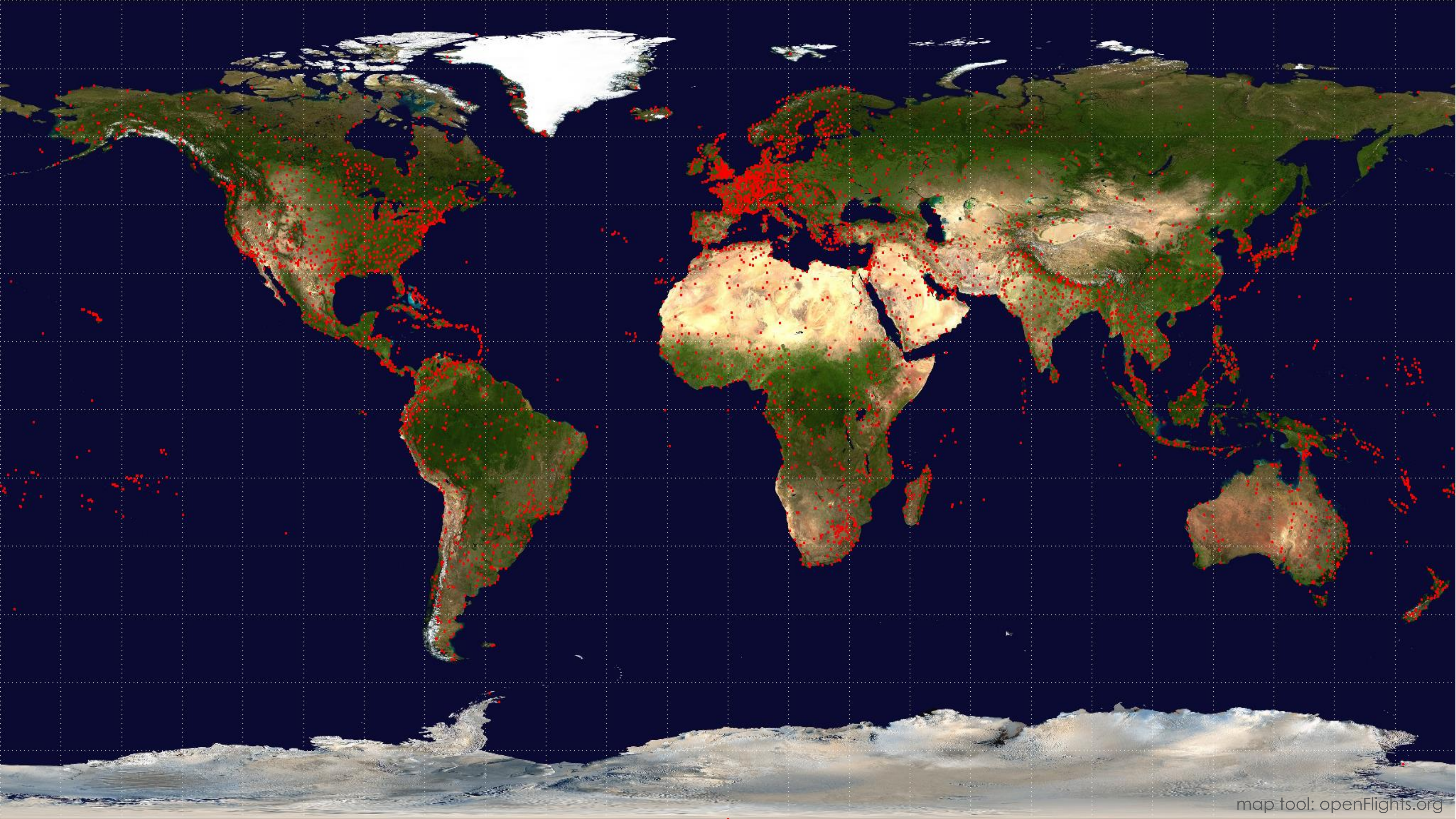
180,000 mi

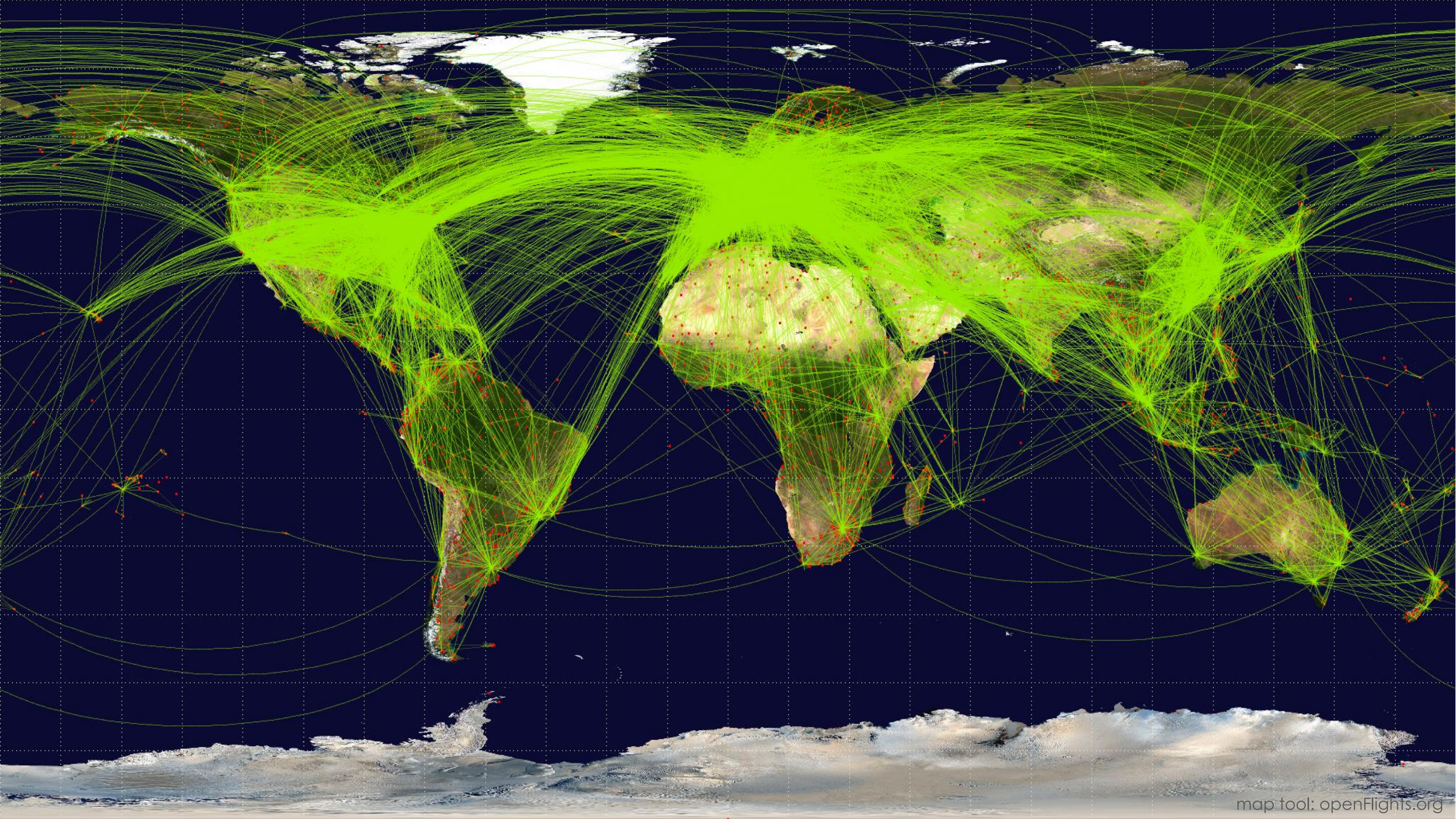
18d 10h 41m

100% misery

arpa·e

map tool: openFlights.org


map tool: openFlights.org

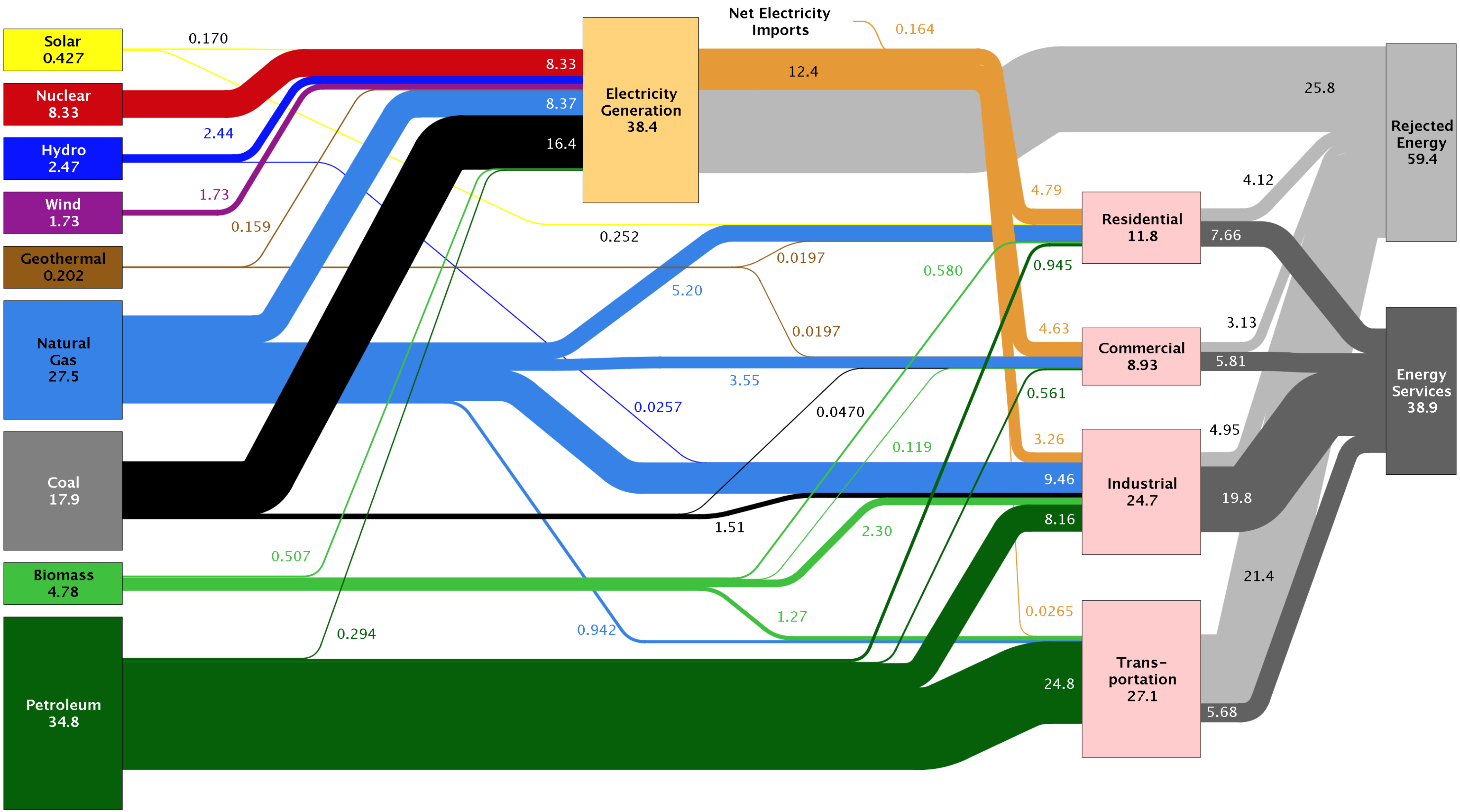

map tool: openFlights.org

air travel = 2 Q

passenger = 18 Q

Estimated U.S. Energy Use in 2014: ~98.3 Quads

Lawrence Livermore National Laboratory



Source: LLNL 2015. Data is based on DOE/EIA-0035(2015-03), March, 2014. If this information or a reproduction of it is used, credit must be given to the Lawrence Livermore National Laboratory and the Department of Energy, under whose auspices the work was performed. Distributed electricity represents only retail electricity sales and does not include self-generation. EIA reports consumption of renewable resources (i.e., hydro, wind, geothermal and solar) for electricity in BTU-equivalent values by assuming a typical fossil fuel plant "heat rate." The efficiency of electricity production is calculated as the total retail electricity delivered divided by the primary energy input into electricity generation. End use efficiency is estimated as 65% for the residential and commercial sectors 80% for the industrial sector, and 21% for the transportation sector. Totals may not equal sum of components due to independent rounding. LLNL-MI-410527

arpa.e has invested in advanced transportation since the beginning

.natural gas vehicles
.electric vehicles
.lightweighting
.optimal route planning and incentives
.powertrain efficiency for autonomous vehicles
.etc

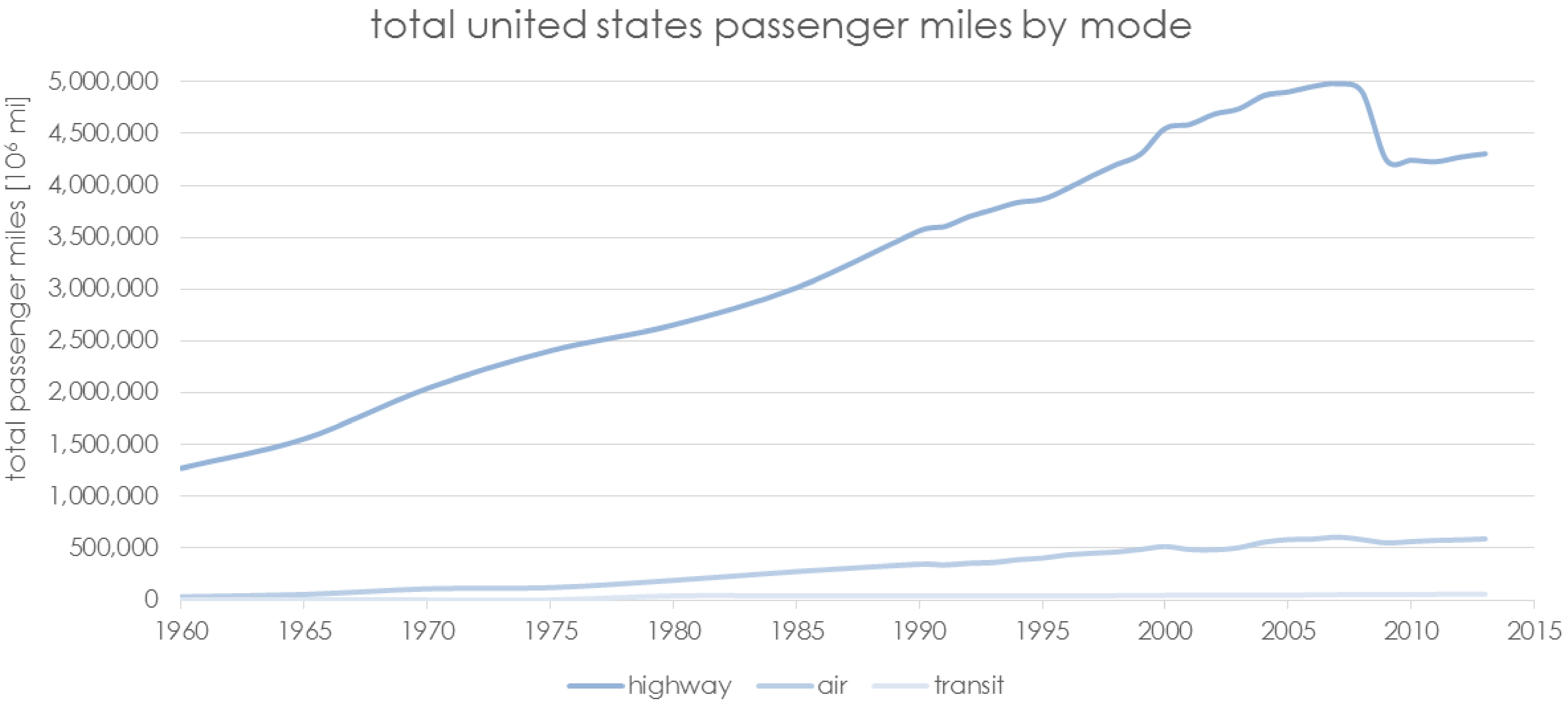
unifying theme:
the new technologies we develop must have market pull
(or else they won't matter)

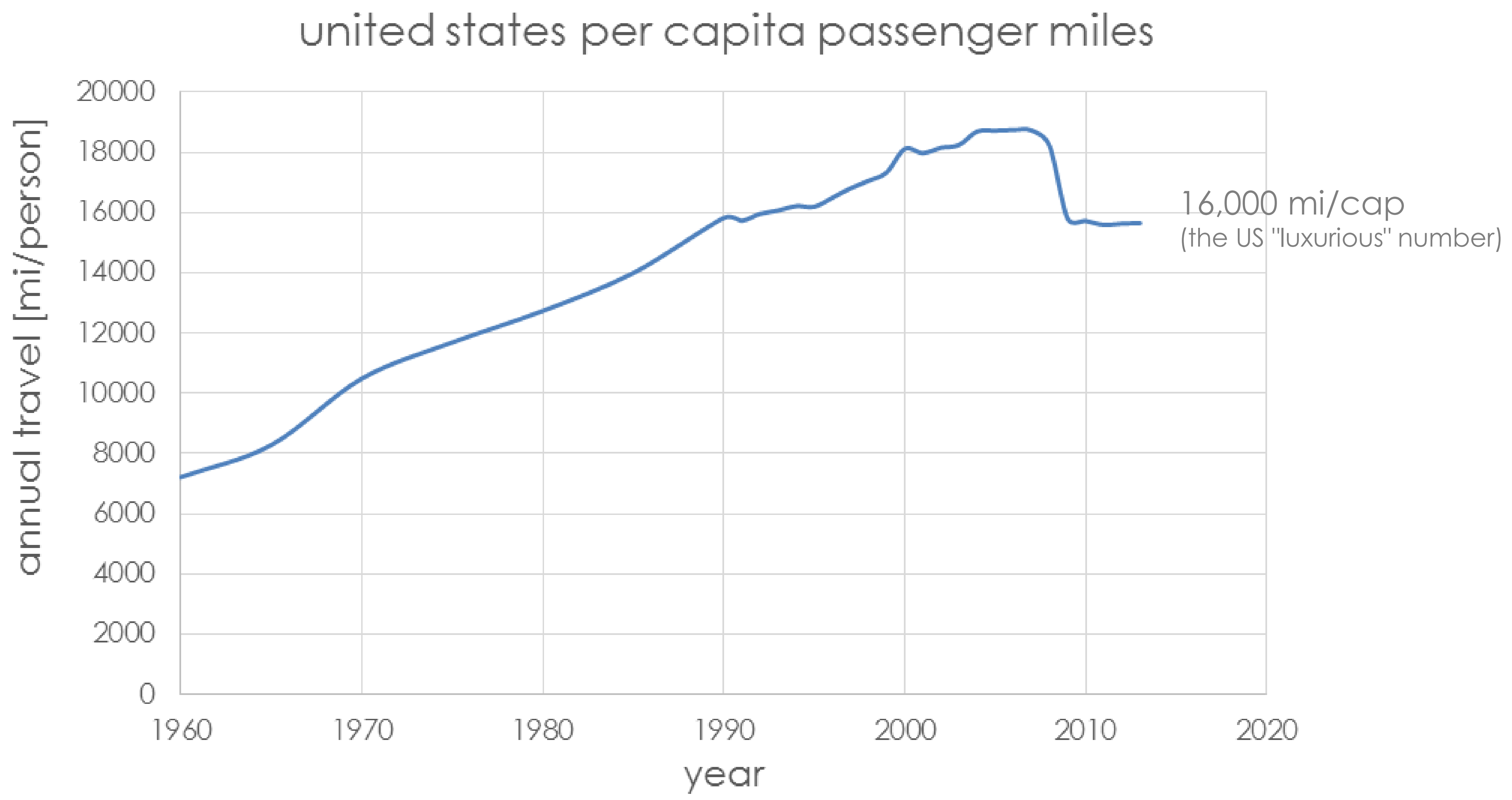
market pull => make transportation better => cheaper, faster, convenient

JEVON'S PARADOX

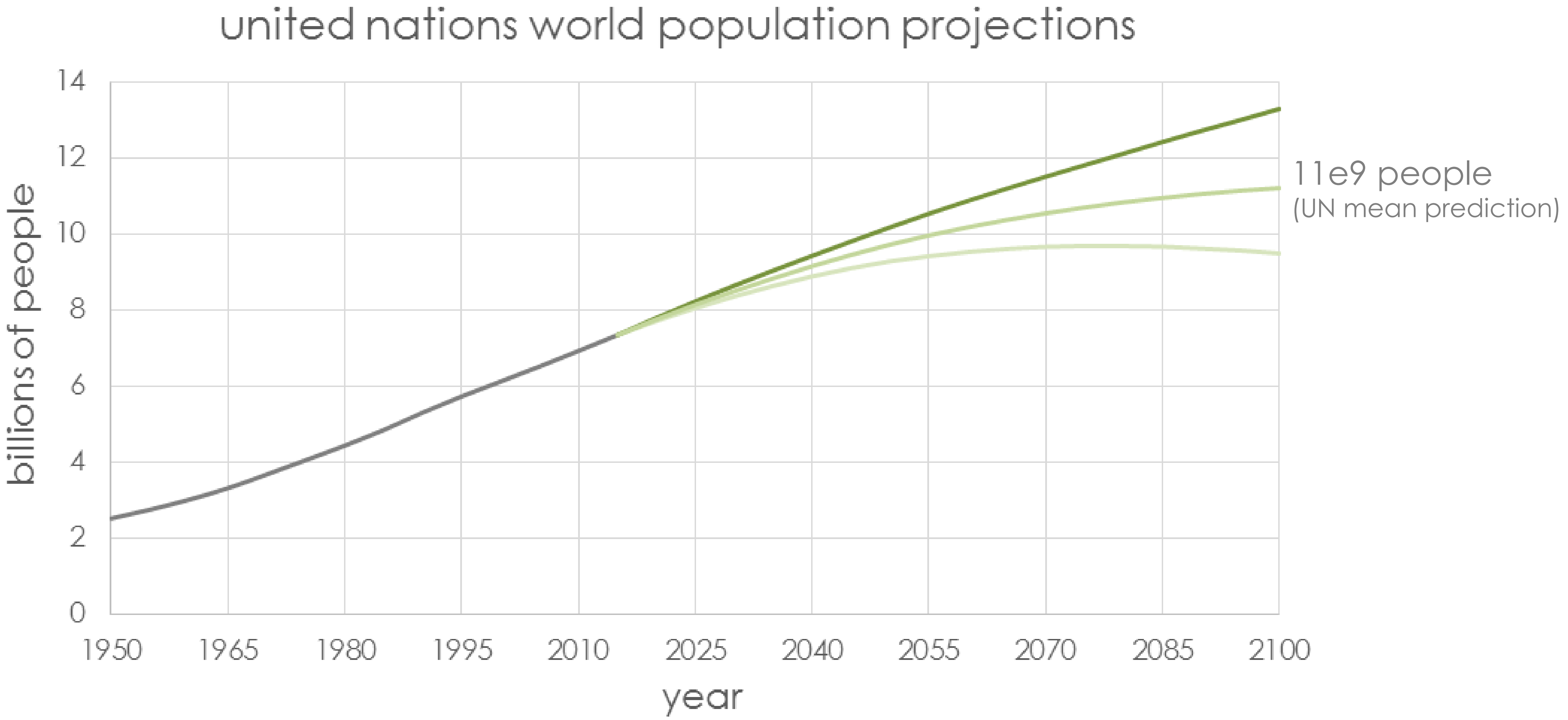
In economics, the **Jevons paradox** (/ˈdʒɛvənz/; sometimes **Jevons effect**) occurs when technological progress increases the efficiency with which a resource is used (reducing the amount necessary for any one use), but the rate of consumption of that resource rises because of increasing demand.[1] The Jevons paradox is perhaps the most widely known paradox in environmental economics.[2] However, governments and environmentalists generally assume that efficiency gains will lower resource consumption, ignoring the possibility of the paradox arising.[3]

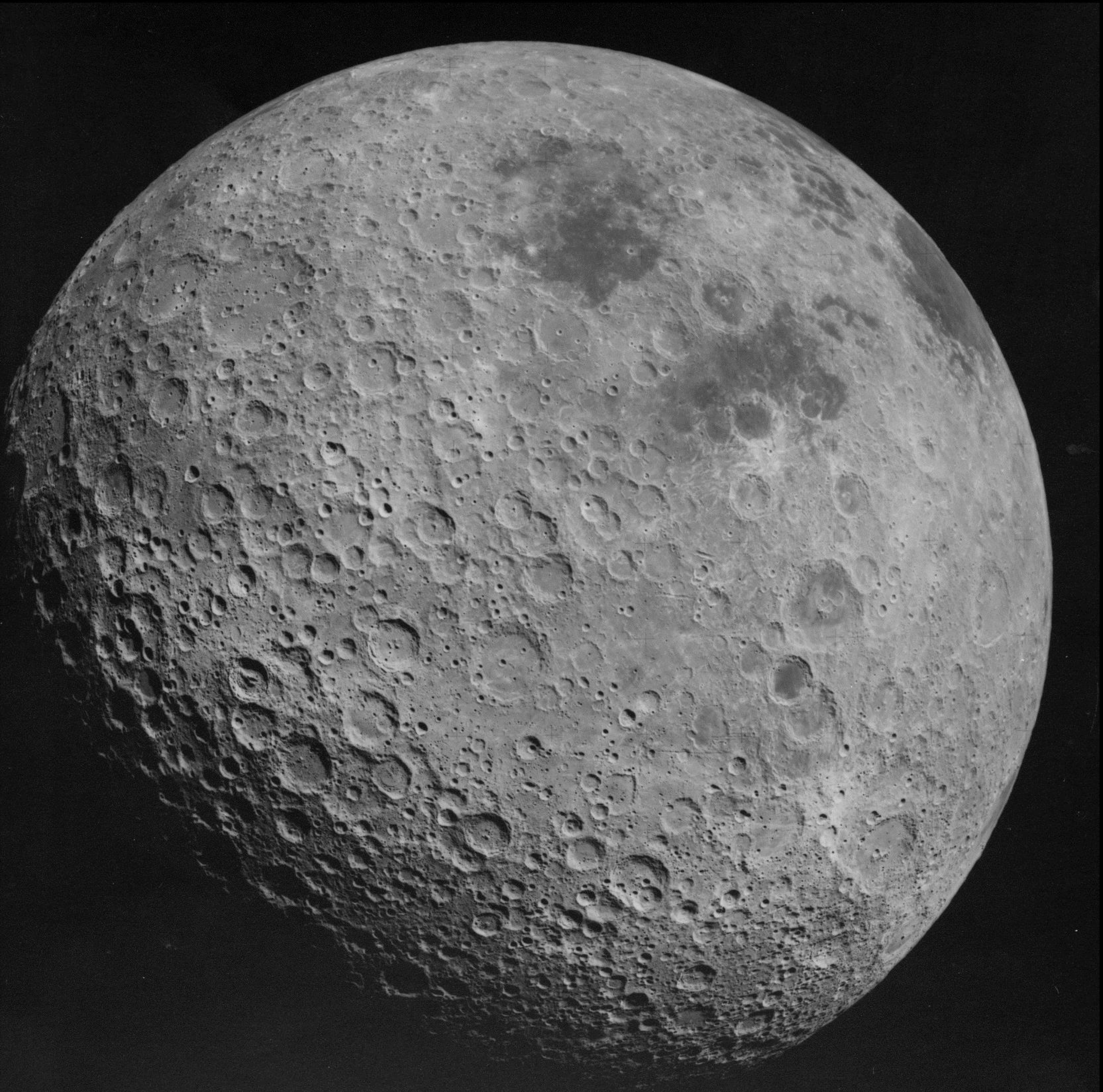
-Wikipedia.


total united states passenger miles by mode
total passenger miles [10⁶ mi]
5,000,000
4,500,000
4,000,000
3,500,000
3,000,000
2,500,000
2,000,000
1,500,000
1,000,000
500,000
0
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
highway
air
transit



united states per capita passenger miles
annual travel [mi/person]
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
1960
1970
1980
1990
2000
2010
2020
year
16,000 mi/cap
(the US "luxurious" number)

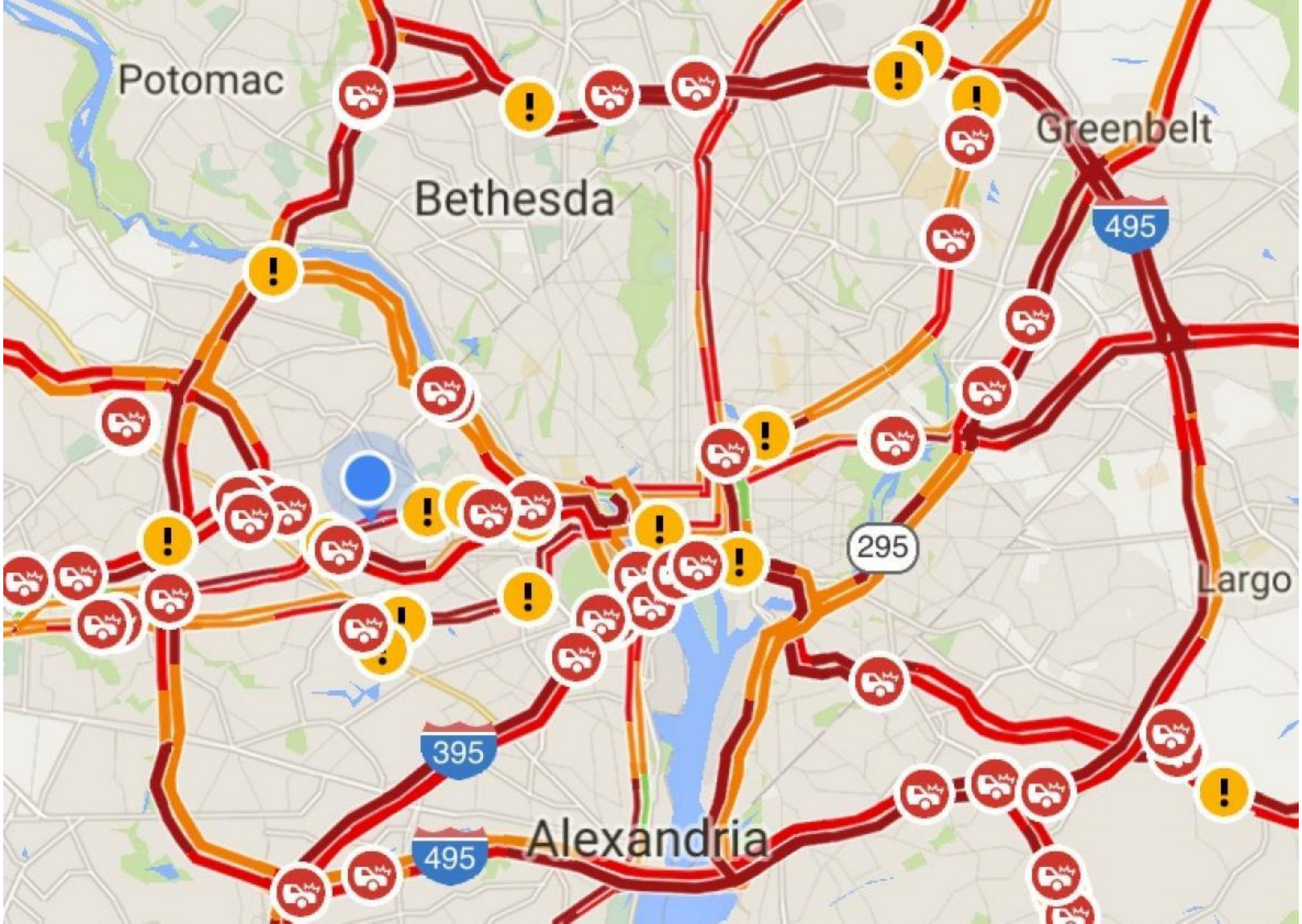

united nations world population projections
billions of people
year
0
2
4
6
8
10
12
14
1950
1965
1980
1995
2010
2025
2040
2055
2070
2085
2100
11e9 people
(UN mean prediction)



1 moon round trip

= 460,200 mi

= 36% of lifetime miles


Potomac
Bethesda
Greenbelt
495
295
Largo
395
495
Alexandria

Wikipedia
The Free Encyclopedia

Main page
Contents
Featured content
Current events
Random article
Donate to Wikipedia
Wikipedia store

Interaction
Help
About Wikipedia
Community portal
Recent changes
Contact page

Tools
What links here
Related changes
Upload file
Special pages
Permanent link
Page information
Wikidata item

China National Highway 110 traffic jam

From Wikipedia, the free encyclopedia

The **China National Highway 110 traffic jam** was a recurring[1] massive traffic jam that began to form on August 14, 2010, mostly on China National Highway 110 (G110) and Beijing–Tibet expressway (G6), in Hebei and Inner Mongolia.[2][3] The traffic jam slowed down thousands of vehicles for more than 100 kilometres (60 mi) and lasted for more than ten days.[3][4][5] Many drivers were able to move their vehicles only 1 km (0.6 mi) per day, and some drivers reported being stuck in the traffic jam for five days.[5] It is considered to be one of the longest traffic jams by some media.[6][7][8]

Contents [hide]

Cause [edit]

Traffic on the China National Highway 110 had grown 40 percent every year in the previous several years, making the highway chronically congested.[5] The traffic volume at the time of the incident was 60% more than the design capacity.[9]

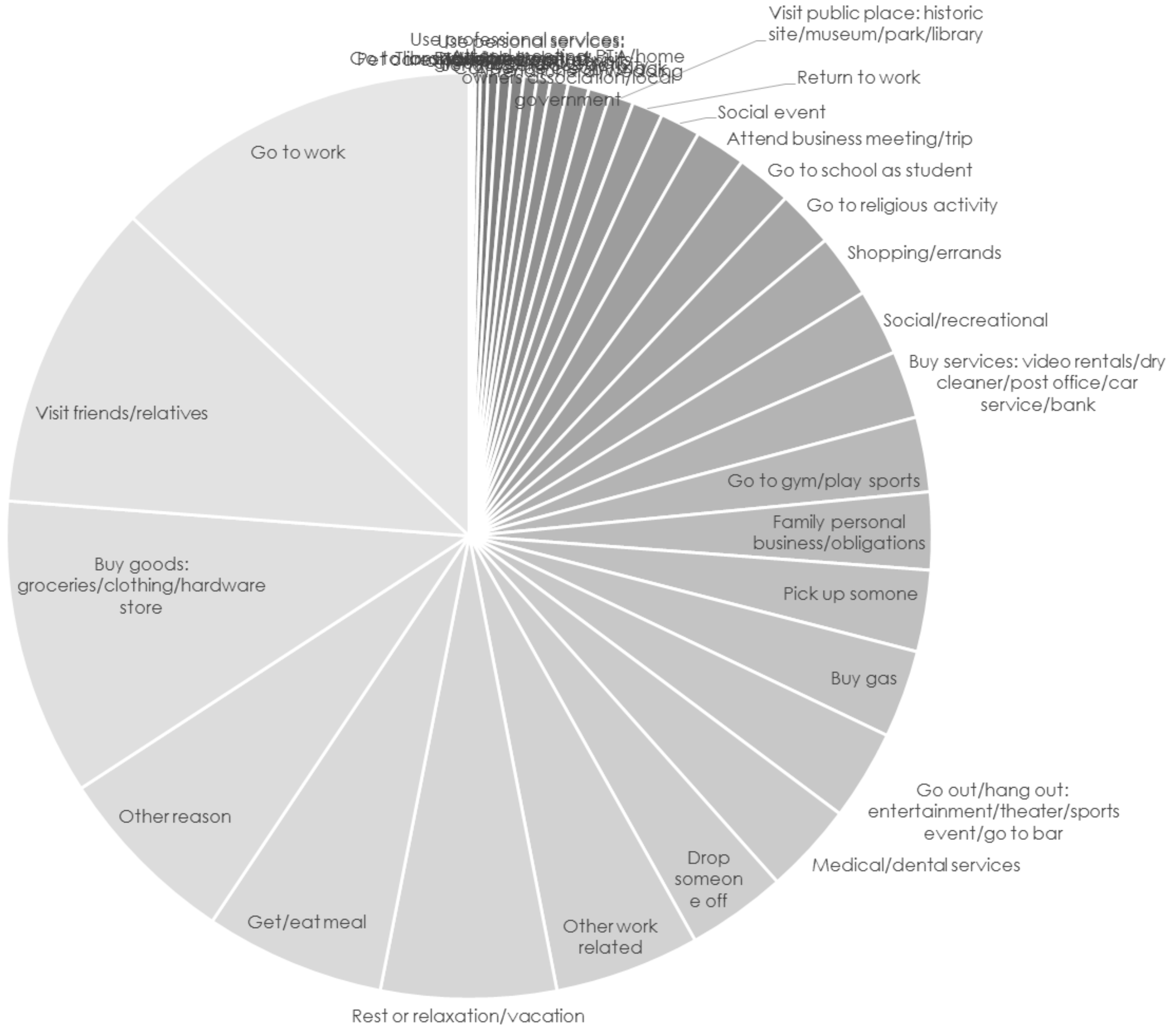
The cause of the traffic jam was reported to be a spike in traffic by heavy trucks heading to Beijing, along with

In 1894, the *Times of London* estimated that by 1950 every street in the city would be buried nine feet deep in horse manure.

One New York prognosticator of the 1890s concluded that by 1930 the horse droppings would rise to Manhattan’s third-story windows.

150,000 horses at 15-30 lbs/day > 3,000,000 lbs/day

nhts travel purposes



passenger transportation trichotomy

we transport ourselves with the objective of:

communication

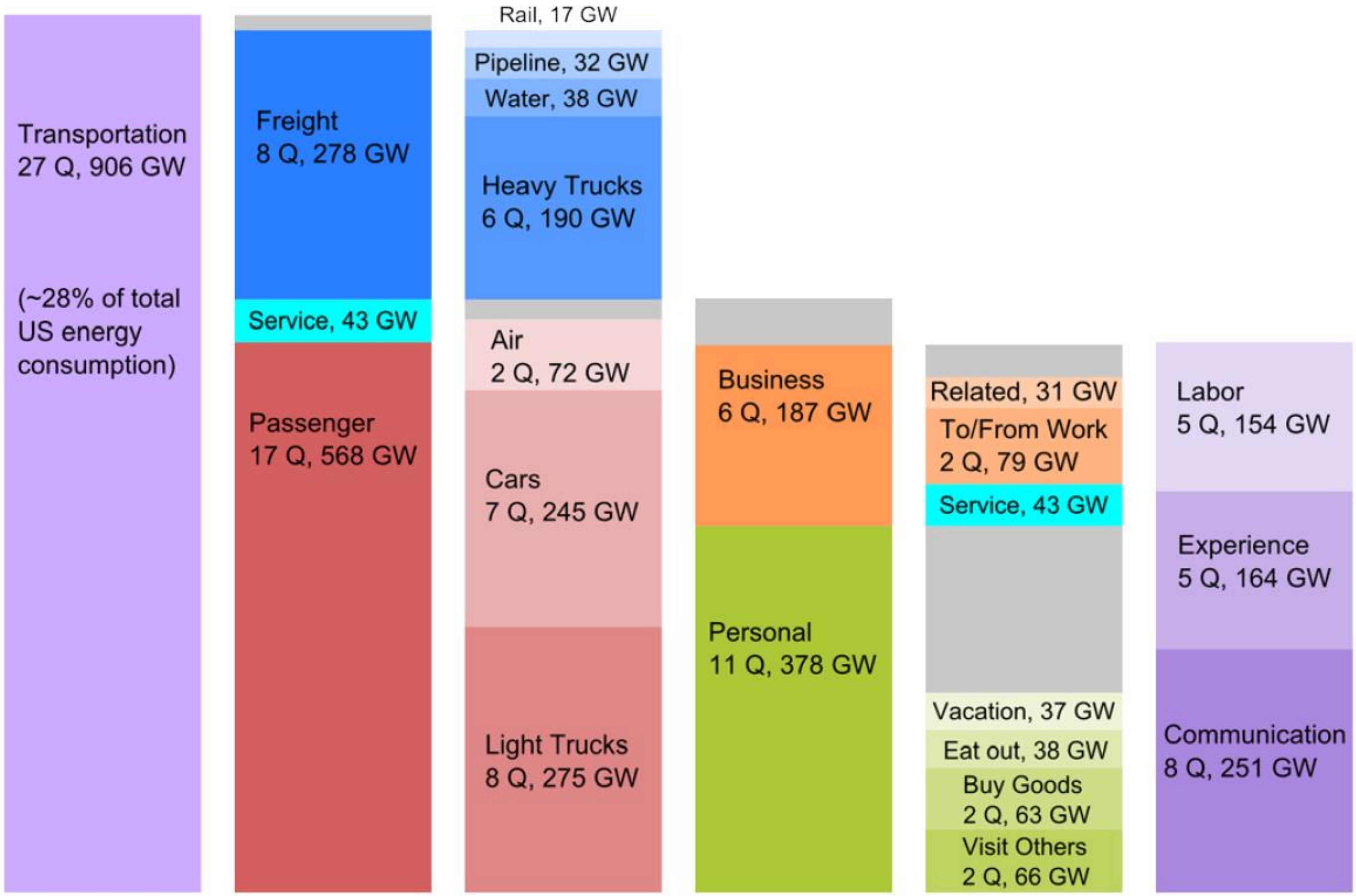
to convey or consume information

labor

to physically affect environment

experience

predominantly to "experience"


Transportation
27 Q, 906 GW
(~28% of total US energy consumption)
Freight
8 Q, 278 GW
Service, 43 GW
Passenger
17 Q, 568 GW
Rail, 17 GW
Pipeline, 32 GW
Water, 38 GW
Heavy Trucks
6 Q, 190 GW
Air
2 Q, 72 GW
Cars
7 Q, 245 GW
Light Trucks
8 Q, 275 GW
Business
6 Q, 187 GW
Personal
11 Q, 378 GW
Related, 31 GW
To/From Work
2 Q, 79 GW
Service, 43 GW
Vacation, 37 GW
Eat out, 38 GW
Buy Goods
2 Q, 63 GW
Visit Others
2 Q, 66 GW
Labor
5 Q, 154 GW
Experience
5 Q, 164 GW
Communication
8 Q, 251 GW

someday, we will only travel when we want to.

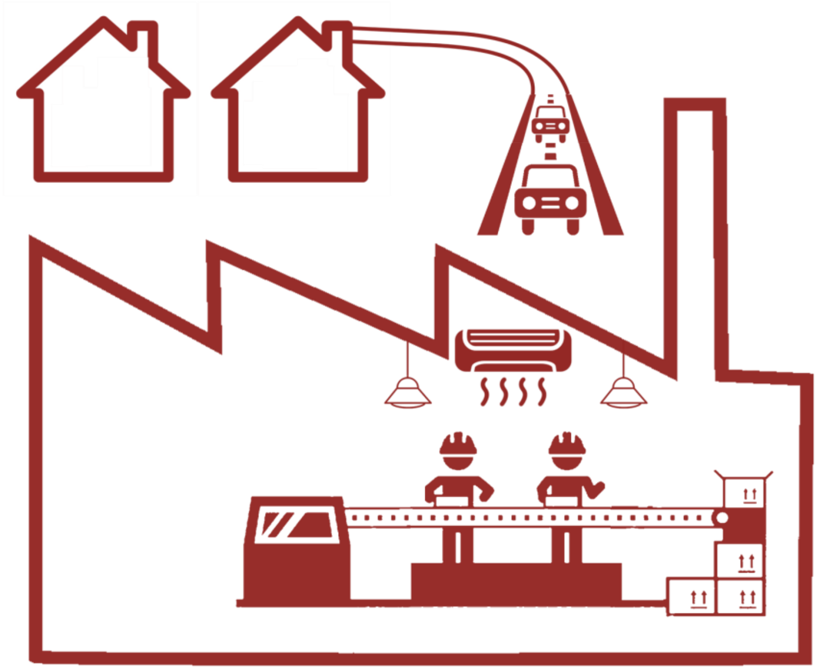
(and transportation energy will plummet) day 1: telecommunication

day 2: telelabor

opportunities in "telelabor"

Jason Rugolo, Ph.D.	Program Director
Justin Manzo, Ph.D.	Tech SETA
Geoff Short, Ph.D.	Tech SETA
Paul D'Angio, Ph.D.	Tech SETA
Mike Kane, Ph.D.	Fellow

arpa·e



drawings: Mike Kane

bring telework to labor jobs

drawings: Mike Kane

serious limitations

. hardware cost
. perception
. intelligence
. decision making
. implementation

drawings: Mike Kane

drawings: Mike Kane

let humans do what they’re good at,
and leave the rest to robots.

let humans do what they're good at,
and leave the rest to robots.

advantages of telelabor

. save on passenger travel
. process intensification
. save on HVAC
. save on lighting
. increase productivity
. make labor workers happier
. use cheaper robots
. less expensive implementation

drawings: Mike Kane

telelabor makes labor jobs better.
autonomy eliminates them.

why don't we do this already?

we've started, but it's hard and expensive.


ABB
ABB
ABB
ABB
Fanta
Fanta

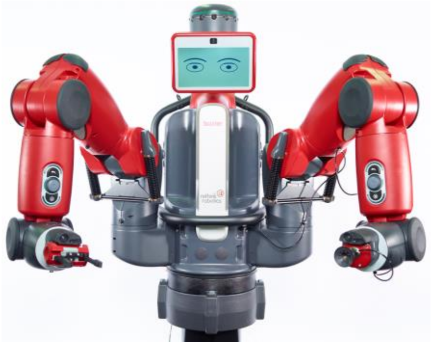

2
1


RightHand
Robotics



ABB


i-limb ultra
touch

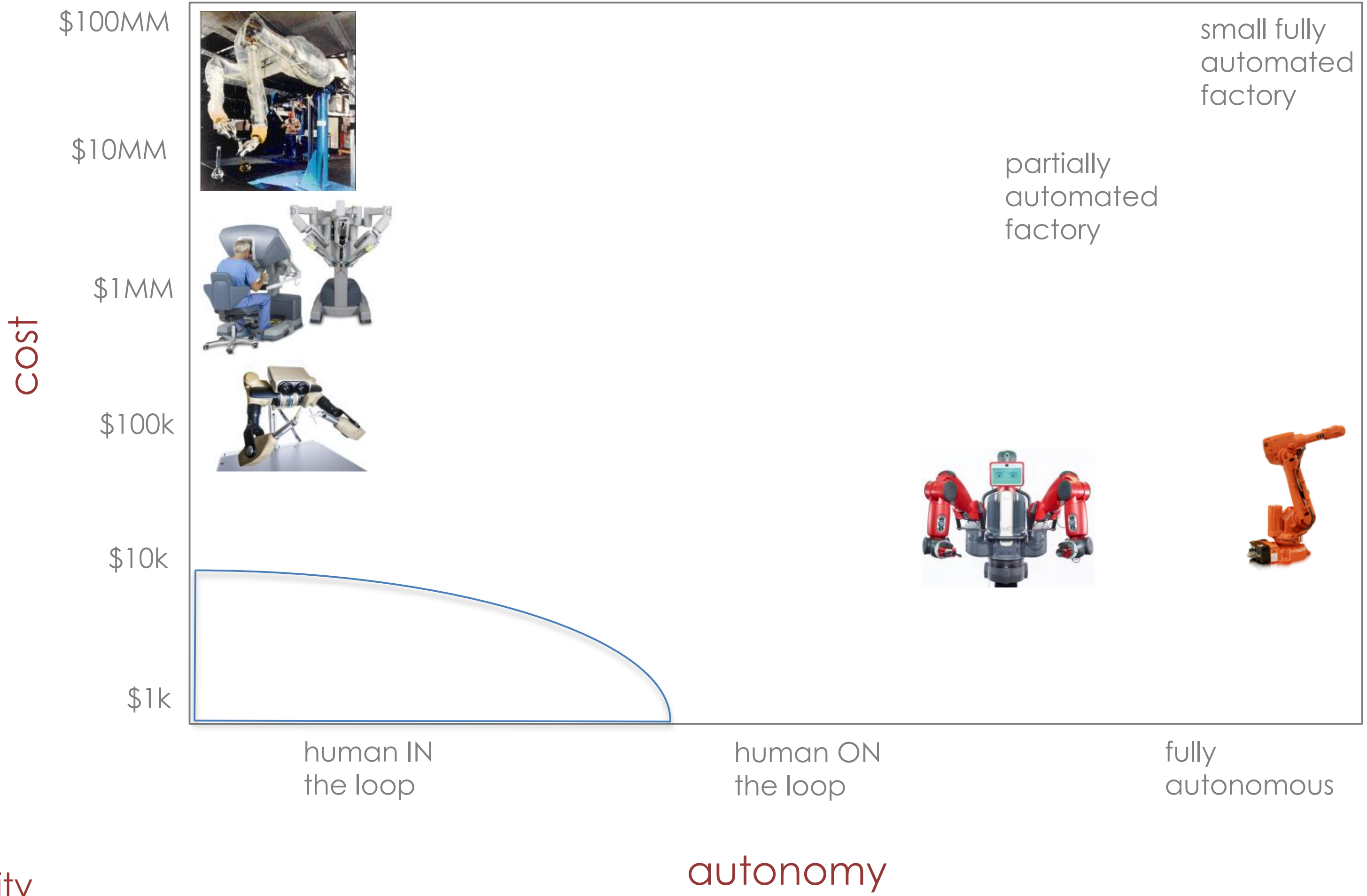



KINOVA

how do we control these manipulators? the human machine interface

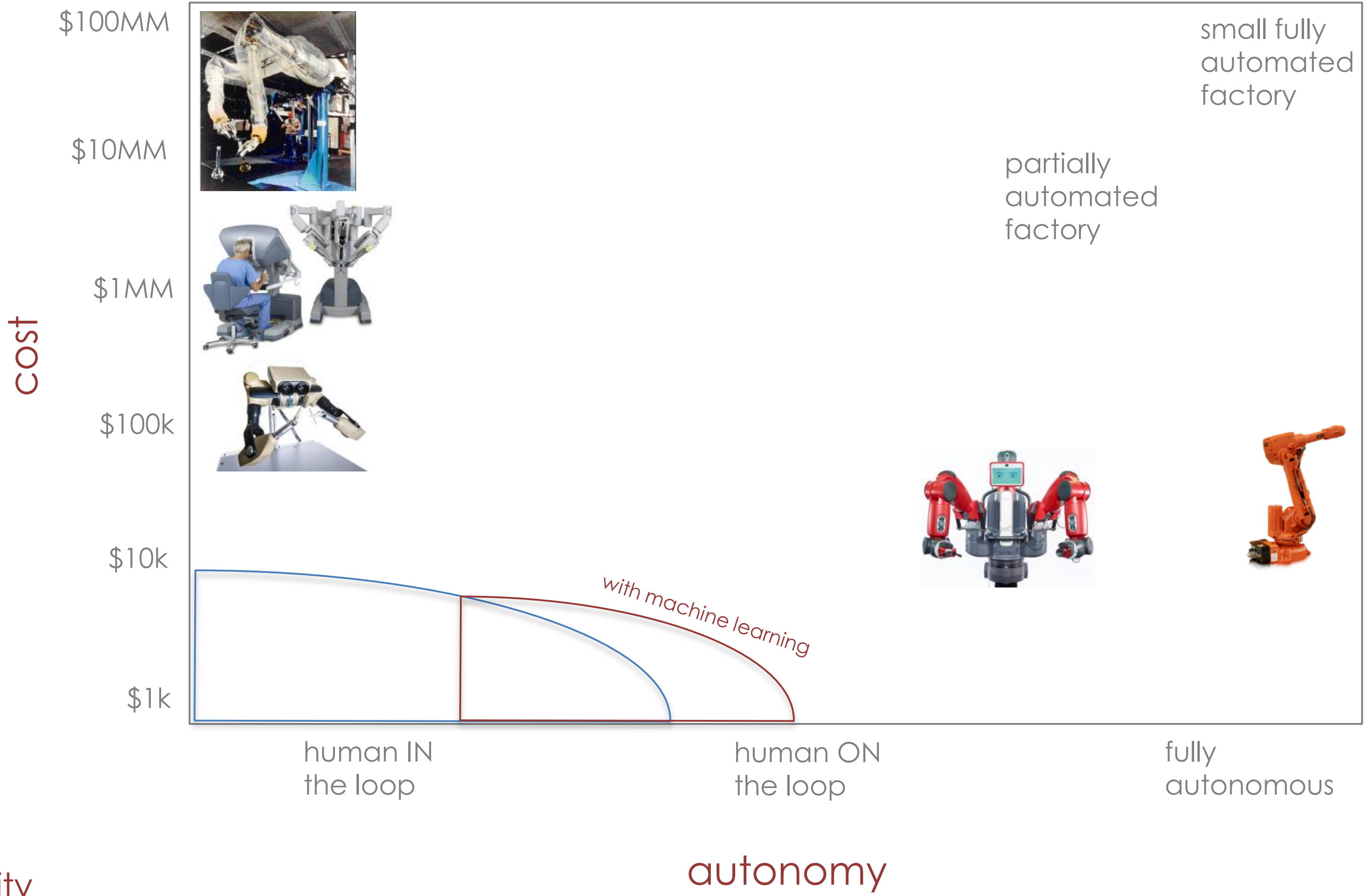
. operator immersion
. better perception
. facile controls
. role of hapitcs
. 3d
. extra-sensory
. sliding autonomy
. minimal cognitive loading
. minimal physical loading

robotic manipulation technical space



3rd axis: capability

robotic manipulation technical space



3rd axis: capability

other applications in energy:

nuclear plants
wind turbine blade inspecting
harsh or dangerous (power lines, oil derrick)
all power plants

dull, dangerous, dirty, …, lot of that in energy.