



Park-and-Ride Success: A GIS Analysis

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Agenda

- The Objective: Examine the effect of park-and-ride availability on the efficiency of bus transit
- Two basic approaches:
 - Route-level analysis
 - Stop-level analysis
- Two Case Studies:
 - King County Metro (Seattle)
 - Santa Clara Valley Transportation Authority [VTA] (San Jose)
- GIS methods employed:
 - Proximity of bus stops and routes to Park-and-Ride (PnR) lots
 - Spatial Statistics
 - Spatial Regression
- Future Issues and Methods
 - Use Network Analyst
 - Develop Python Implementation

Basics of Park & Ride (P&R) in USA and Canada

- Because of existing patterns of residential development, private vehicles are an important means of access to public transit
- P&R extends access to transit beyond the end of the line
- Important in suburban locations for commuting to work
- APTA trade association reports 210K P&R spaces in 360 locations (January 2012)
- Facilities not necessarily owned by transit agencies
- Transit agencies have de-emphasized P&R in recent years – walk & bike access preferred
- But P&R popular with customers when lots offer convenient access, allow parking for low or no cost, and are served by high quality transit.

Example of Park-and-Ride Facility in Bellevue, WA



Policy Issues Background

- Transit agencies often view P&R as an expensive source of riders; walk and bike access is better for environment.
- But given the popularity of P&R, can agency and societal objections be mitigated?
- Solution elements:
 - (1) special treatment for smaller, cleaner cars;
 - (2) users pay more and get more;
 - (3) encourage more passengers per arriving vehicle.
- One potential agency motivation to make an effort: more efficient transit operations.
- Key measure of transit productivity – *boardings per service hour*.

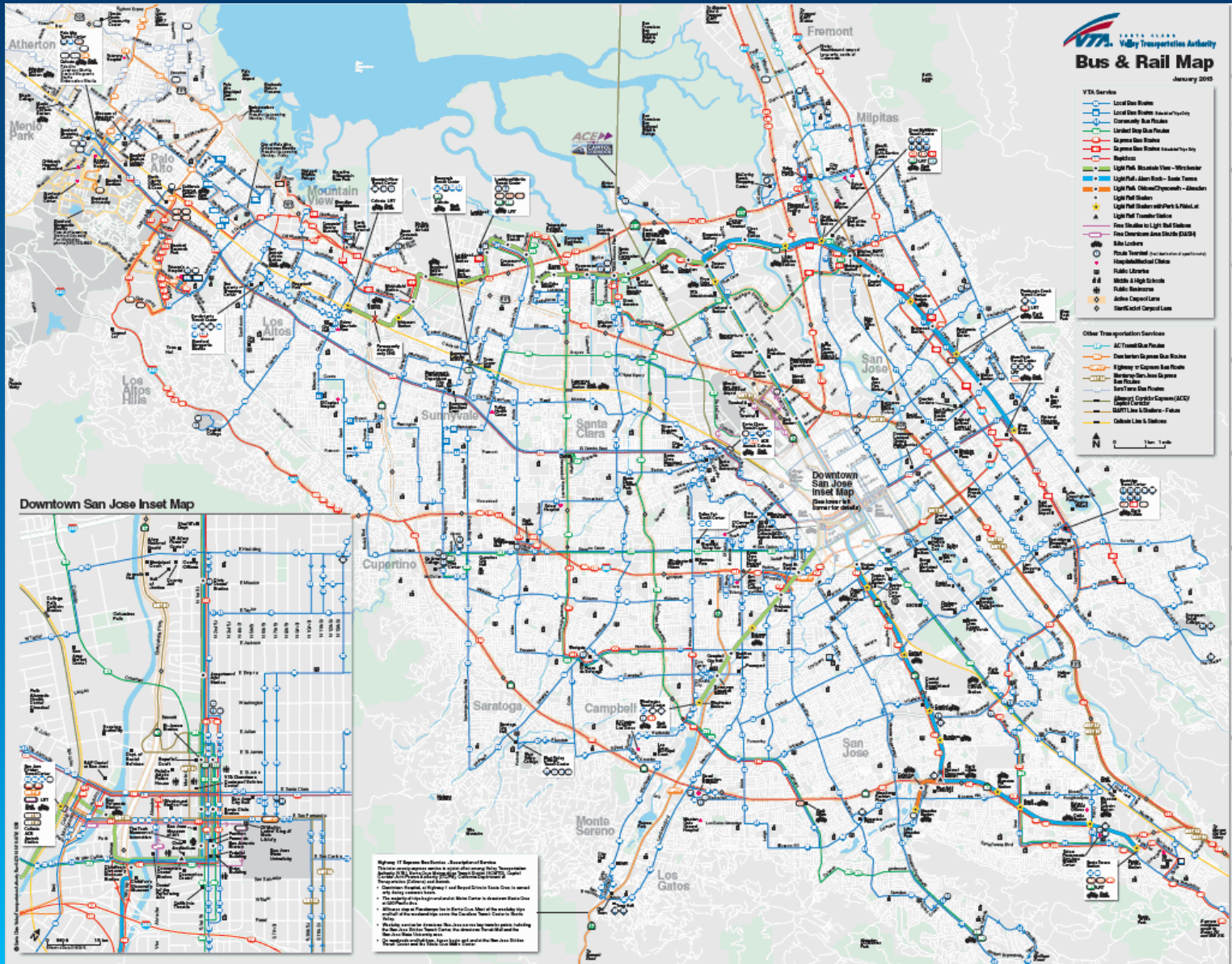
GIS is critical

- Visualizing transit networks and operations
- Turning numerically coded lists of bus stops and boardings into physical understanding
- Facilitating communication between transit planners and outside analysts
- Visualizing and communicating solutions
- Generating data for statistical analyses
- Tools like Network Analyst promise to provide great insights

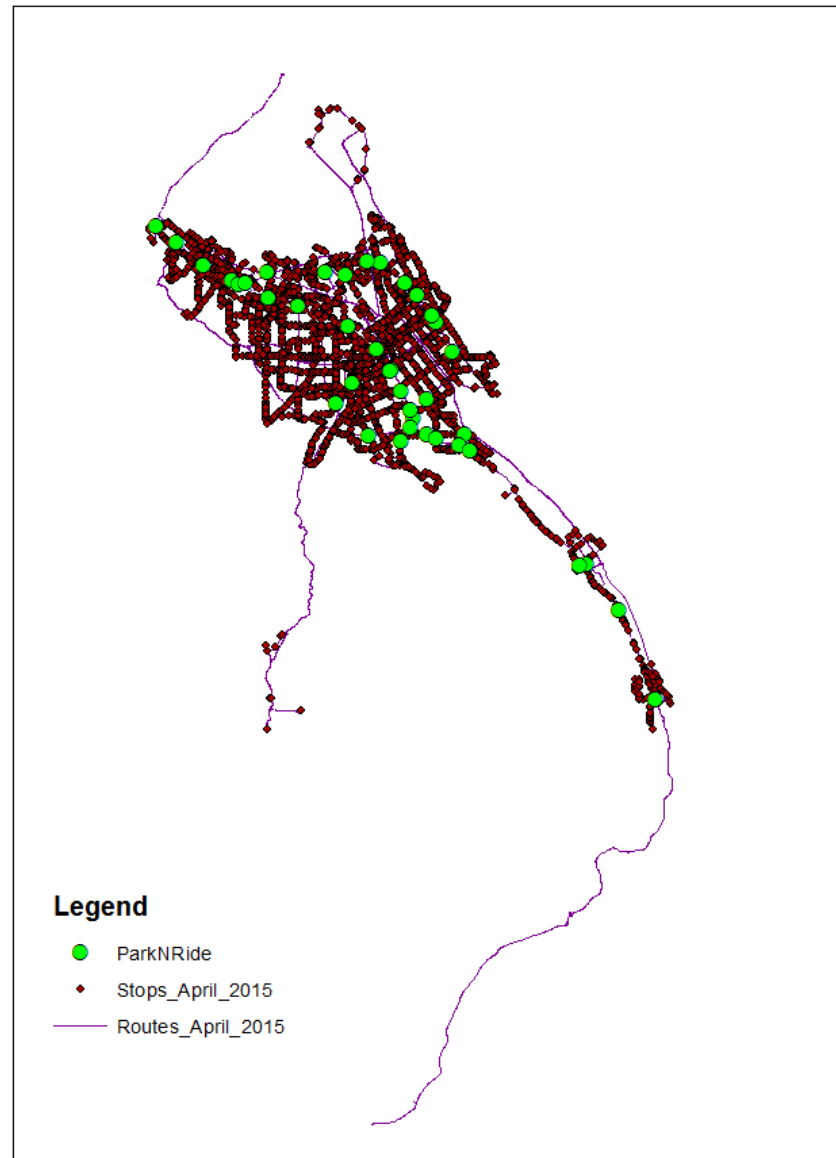
Overview of VTA

- Serves Santa Clara County (and parts of Alameda and San Mateo Counties)
- Includes bus and light rail
- 440 buses in peak service
- 34th largest transit agency in USA by ridership
- 40 Park & Ride lots operated by VTA

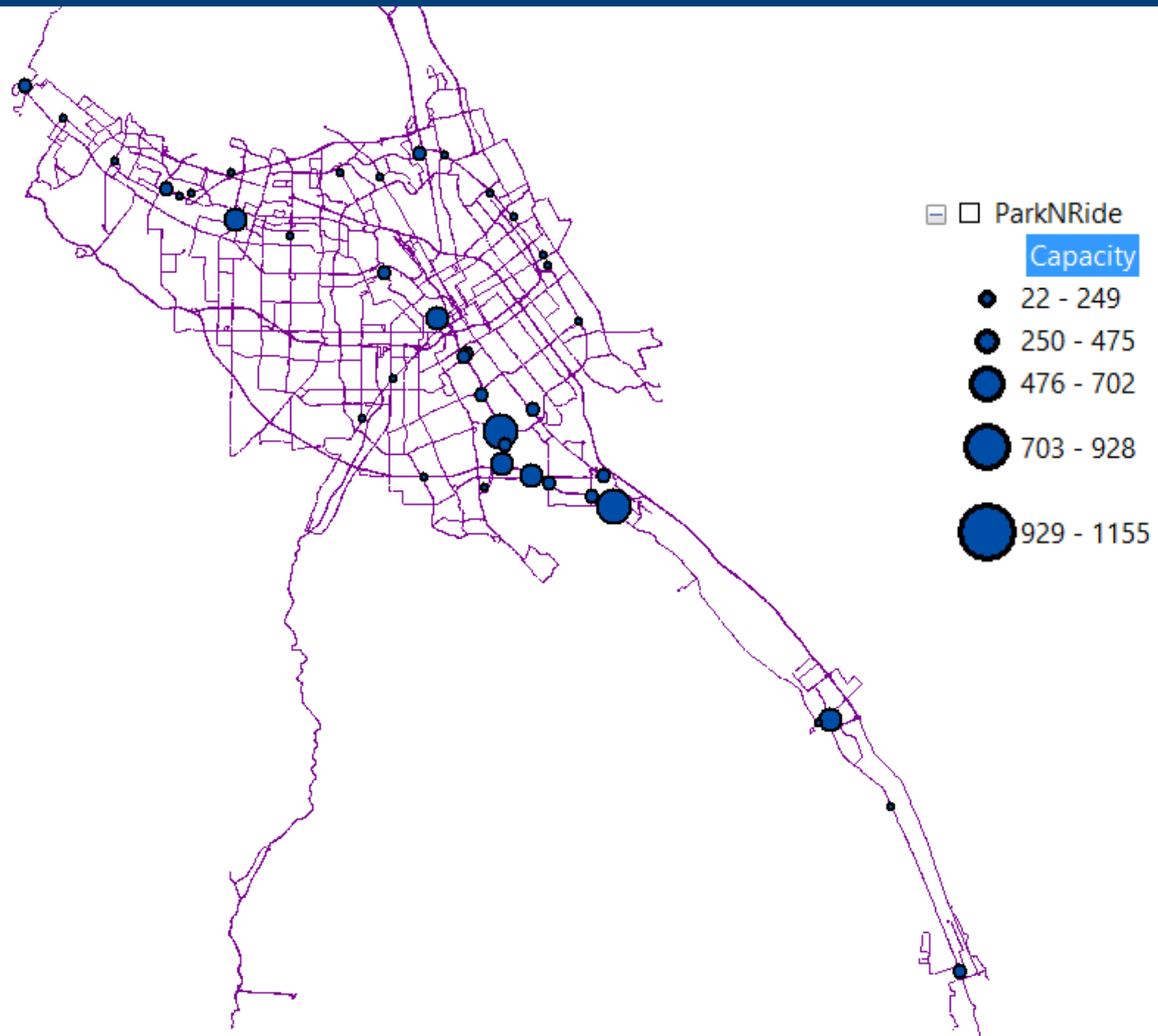
The VTA System



VTA Routes, Stops, and PnR Lots



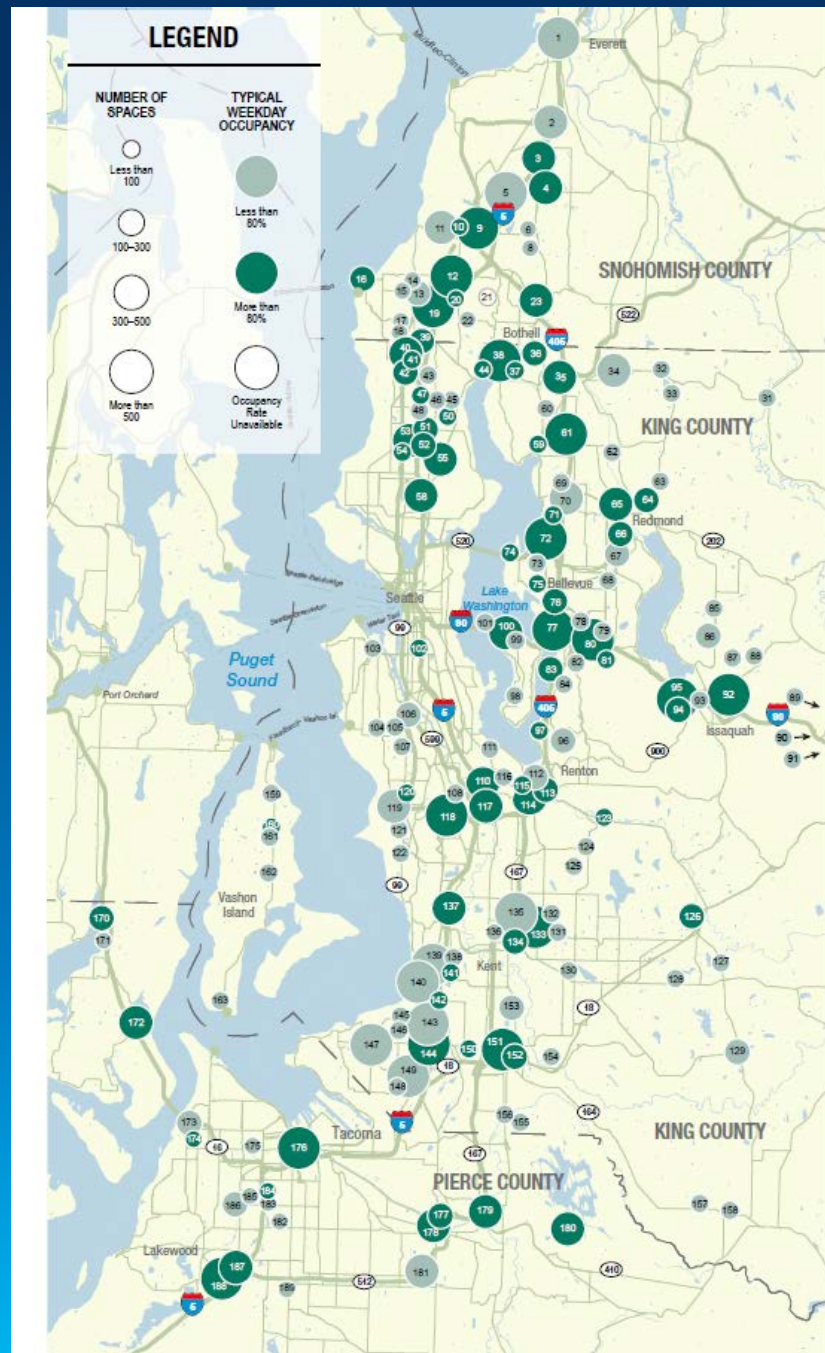
VTA Routes and P&R Lots by Capacity



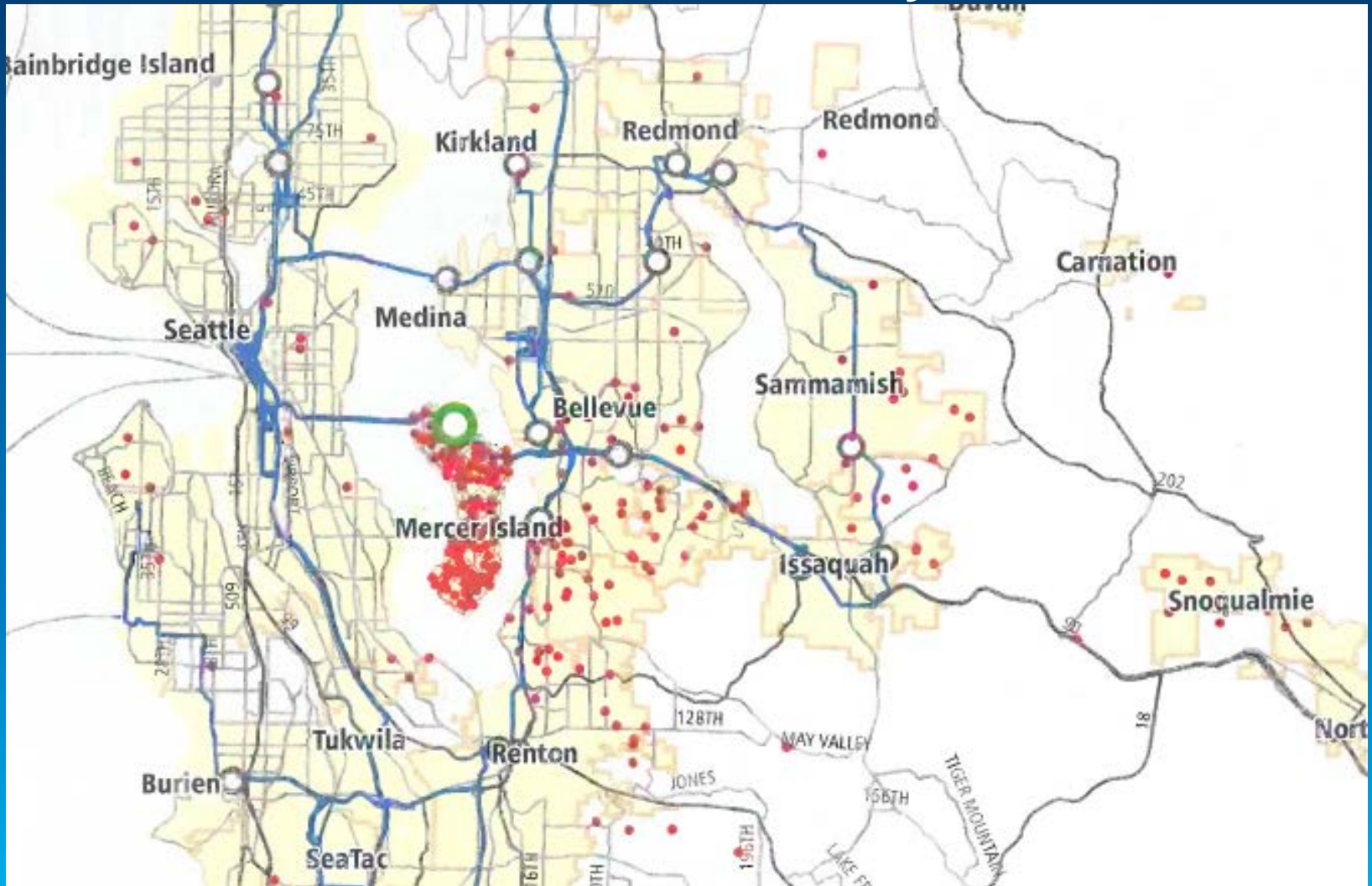
Overview of King County Metro

- **Seattle, Bellevue Washington and vicinity**
- **1,500 buses in peak service**
- **9th largest transit agency in USA by ridership**
- **11.6% weekday average transit share of commuters**
- **130 Park & Ride lots used by about 20,000 customers daily**
- **39% of riders surveyed used P&R in the last 30 days.**

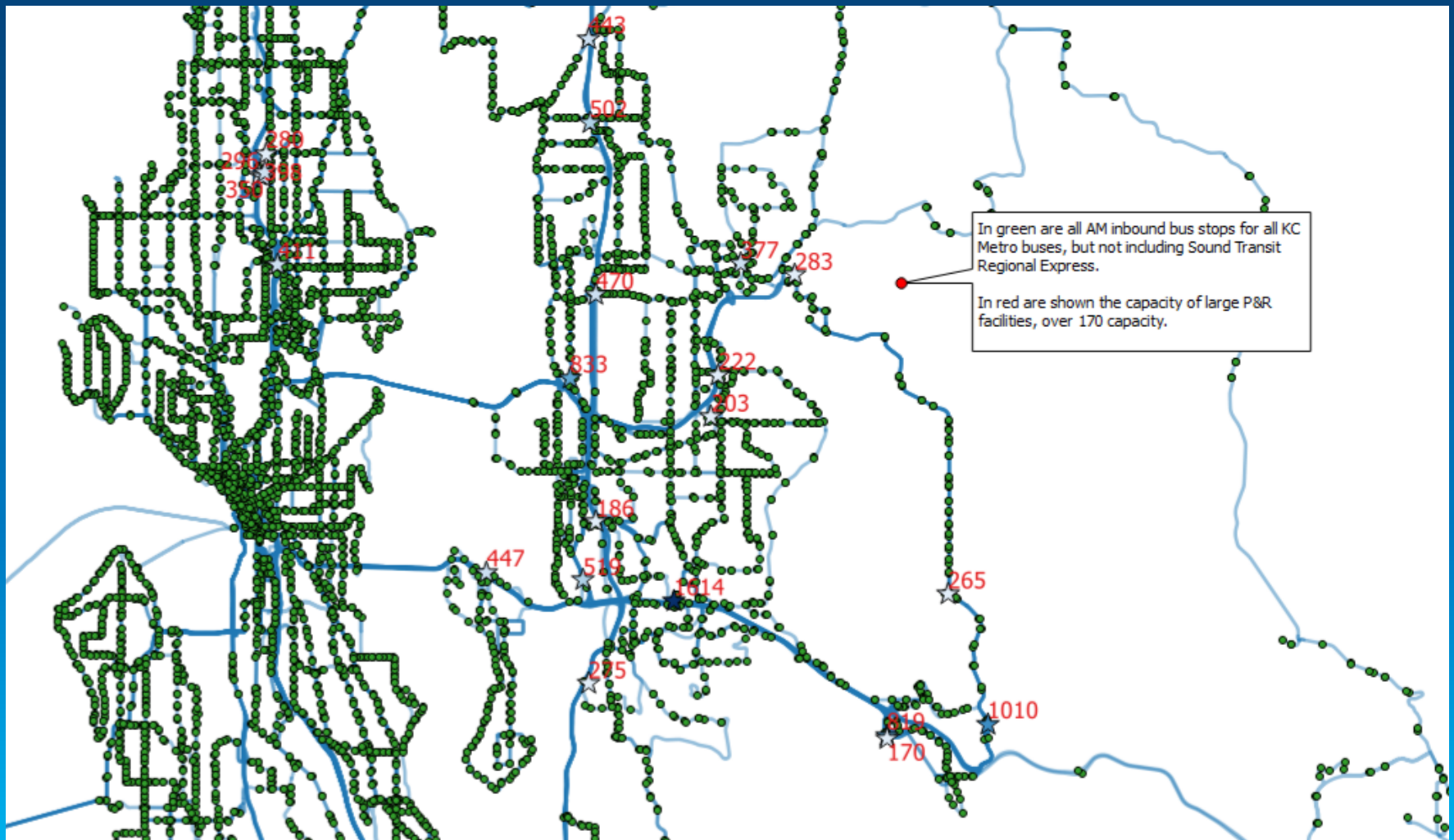
Seattle Region's P & R Lots



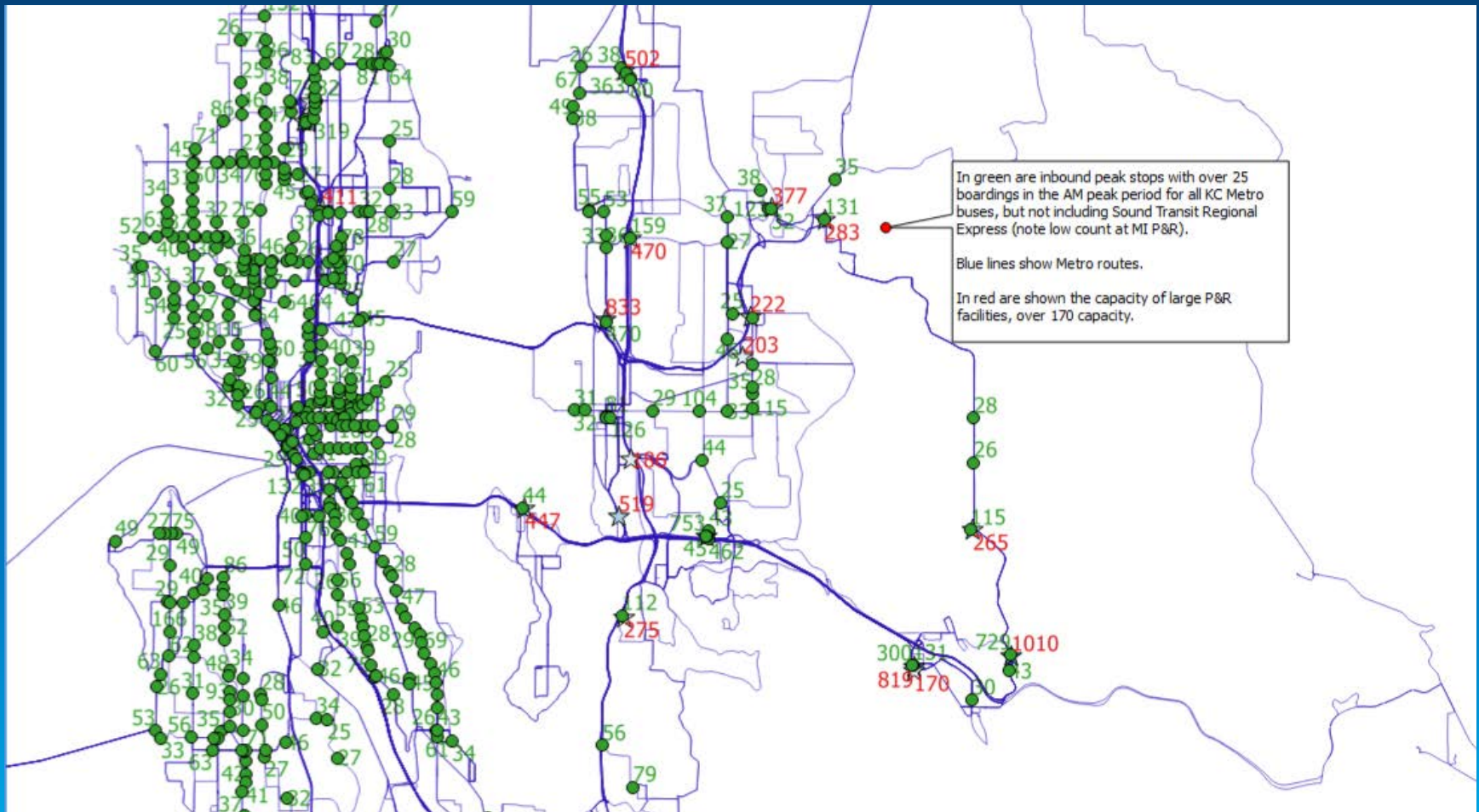
GIS Visualization of P&R Customer Origins Determined via License Plate Survey



All the King County Bus Stops



Large P&R Facilities are Prominent Among the Most Highly Used King County Suburban Bus Stops



Route-level Analysis vs. Stop-level Analysis

Route-level Analysis examines the ridership on a route or busline over the course of a specific period. It may measure the additional ridership on the route associated with stops close to P&R lots.

Pros: Fiscal impact is often thought of by public transit agencies at the route level

Cons: There are fewer routes than stops, so some stop-level detail is sacrificed, and the number of observations is smaller than with stop-level data; harder to incorporate demographic and economic data related to the neighborhood of a stop

Stop-level Analysis examines the ridership at a particular stop (that may be served by several routes). Stops close to P&R lots can be identified.

Pros: More observations and more easily associated with economic and demographic characteristics of the neighborhood

Cons: Not the natural units in which to discuss fiscal impacts in transit, and traditional fiscal impacts may be difficult to analyze

Stop-level regression coefficient estimates for King County Metro (based on inbound stops)

$$\text{Boardings} = \beta_0 + \beta_1(\text{Dummy variable: Located with Quarter Mile of PnR Lot}) + \epsilon$$

$$\beta_0 = 15.949857$$

$$\beta_1 = 49.982603$$

Stop-level Analysis of VTA

Boardings

$= \beta_0$

$+ \beta_1$ (*Dummy variable: Located with Quarter Mile of PnR Lot*)

$+ \epsilon$

$$\beta_0 = .7948004$$

$$\beta_1 = 1.271221$$

Model Developed to Quantify Park & Ride Influence For King County Metro Transit

$$\begin{aligned} & \text{Boardings per hour} \\ &= \beta_0 + \beta_1(\text{AM Park \& Ride influence fraction}) \\ &+ \beta_2(\text{All - day boardings per route mile}) \\ &+ \beta_3(\text{Stops per mile over entire route}) + \epsilon \end{aligned}$$

where the estimated values are:

$$\beta_0 = 7.9$$

$$\beta_1 = 16.6$$

$$\beta_2 = 15.5$$

$$\beta_3 = -2.4$$

- The constant measures other undetermined influences
- All coefficients are highly statistically significant
- The signs on the variable coefficients make physical sense

15% Financial Benefit from Park & Ride Across 53 Bus Routes in the King County suburbs of Seattle

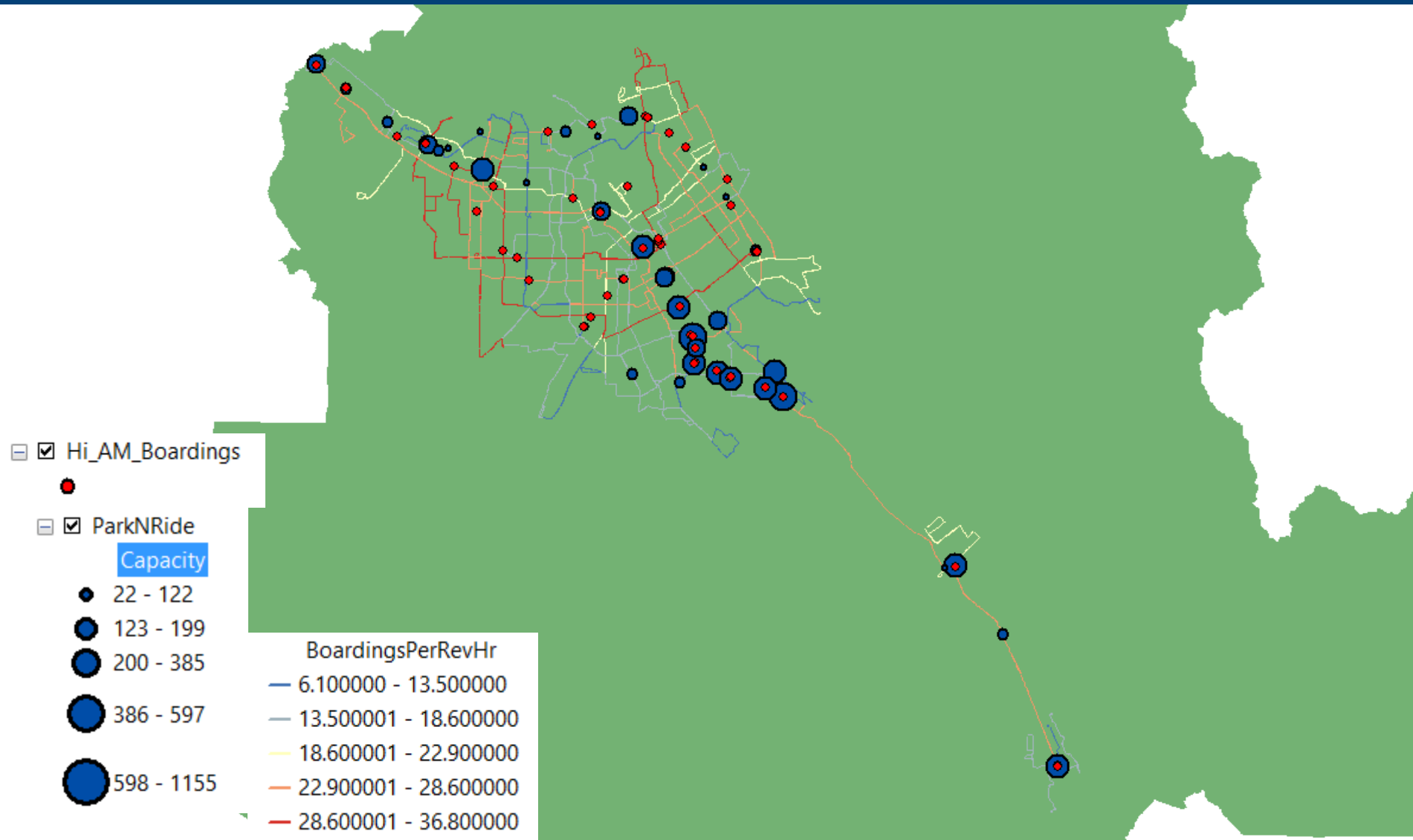
- **The regression coefficient on the P&R influence factor lets us estimate the number of service hours saved by picking up passengers at P&R locations.**
- **Instead of suburban buses having to pick up these riders at bus stops widely scattered over dispersed locations, 50,000 service hours are saved annually by the 41 routes out of 53 stopping at P&R facilities. These hours are worth \$17 million.**
- **In other words, if the beneficial impact of the P&R facilities were not present, instead of \$95 million actually spent, \$112 million in service hours would be spent on the 53 routes.**

Differences in network structure and data availability between the two agencies requires a different methodology for determining park & ride influence on bus productivity in the VTA System

	King County Metro	Santa Clara VTA
Service area size	2000 square miles	346 square miles
Service area population	2 million	1.8 million
Annual bus fare revenue	\$123 million	\$29 million
Annual bus operations cost	\$440 million	\$226 million
Bus cost per service hour	\$159	\$184
Boardings per service hour	36	27
Many long commuter bus routes from park & ride lots	Yes	No
Many bus routes to rail stations	No	Yes

Source: 2013 National Transit Database of Federal Transit Administration and examination of maps

VTA High Productivity Routes, High Boardings Stops, and P&R Lots by Capacity



Data and Data Sources

- **The data about King County Metro:**
 - Stop-level data and route level data provided by KC staff
 - Boardings by route and by bus stop for the AM peak period
 - Annual hours of service for each route
 - Length and number of stops on each of 53 bus routes.
 - GIS Data obtained from public files on the King County web site.
 - Which stops are at P&R facilities and are in the peak direction from maps.
- **The data about VTA**
 - Stop-level data and route level data provided by VTA
 - Boardings by route and by bus stop for AM peak periods determine from boardings and alightings data
 - Annual hours of service for each route
 - Length and number of stops on each of 97 routes
 - GIS Data about stops, routes, and P&R lots obtained from VTA

SUMMARY AND CONCLUSIONS

IMPACT OF PARK AND RIDE ON EFFICIENCY OF TRANSIT

- **Route-level analysis:** Park and ride variables are positive and statistically significant for King County, indicating park-and-ride contributes to greater boardings per revenue hour
- **Stop-level analysis:** Both park and ride dummy variables are positive and statistically significant for King County and VTA, indicating quarter mile proximity to park-and-ride expands the number of boardings at those stops

GIS IS ESSENTIAL IN THE ANALYSIS OF PARK AND RIDE IMPACT ON TRANSIT EFFICIENCY

- ✓ **Geographic view necessary to understand context**
- ✓ **Proximity vital as a measurement of influence**
- ✓ **Spatial statistical & related methods yield essential estimates**

Questions or Comments?

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