

A Techno-Economic Framework for Broadband Deployment in Underserved Areas

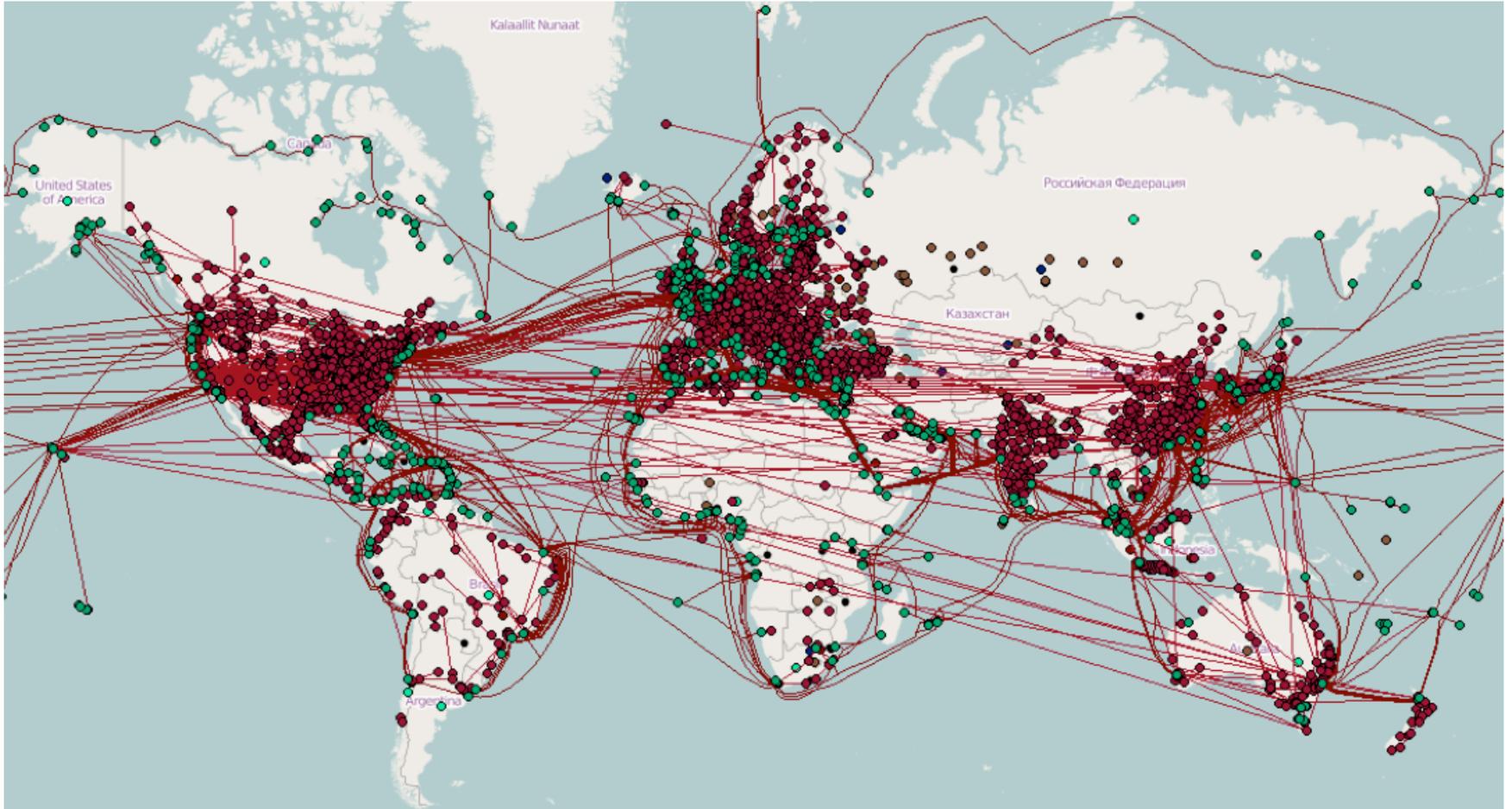
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A view of the Internet



Source: Internet Atlas
<http://internetatlas.org>

Assessing underserved areas

- Economic research has shown strong correlation between broadband connectivity and productivity
 - 6% of Americans lack broadband access
- FCC's national broadband plan (2010)
 - Defines broadband (25Mbps/3Mbps)
 - Provides economic incentives to service providers to deploy infrastructure in un/underserved areas

Research question

How can service providers identify best locations for future deployment efforts?

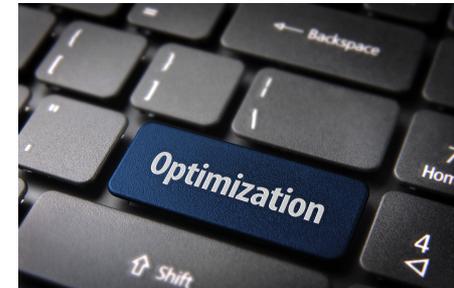
Connectivity
Analysis



Service Provider
Objectives



Techno-Economic
Framework

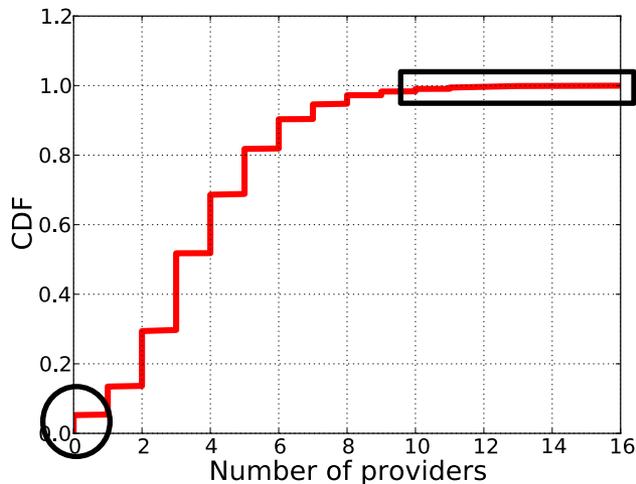


Connectivity analysis

- Assess broadband connectivity in the US counties (and county equivalents)
- Datasets used
 - Provider data from *broadbandmap.gov*
 - Census data from *census.gov*
 - Infrastructure data from *internetatlas.org*
- Goal: Highlight the “digitally divided” regions
 - Prevalence of service providers, infrastructure and underserved communities

Service provider prevalence

- We join the census and provider datasets using FIPS code
- Count the unique number of service providers present in a county

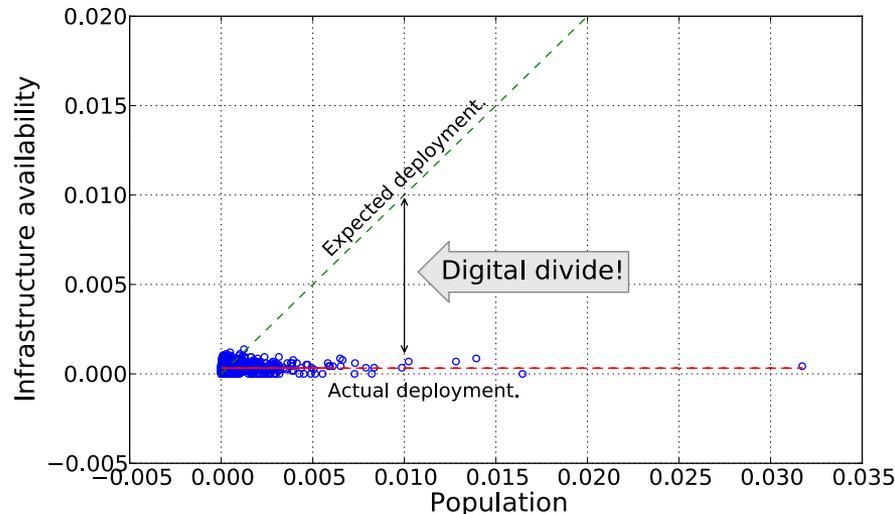


170 counties (i.e., 12% of the US population) does not have *any* provider presence!

Only 1% of the counties have provider presence greater than 10. Provider presence corresponding to fiber assets, IXPs, or cable landing points!

Infrastructure vs. population

- Unique number of providers as a proxy for infrastructure availability
- Intuition: trend in population should follow the trend in the number of providers

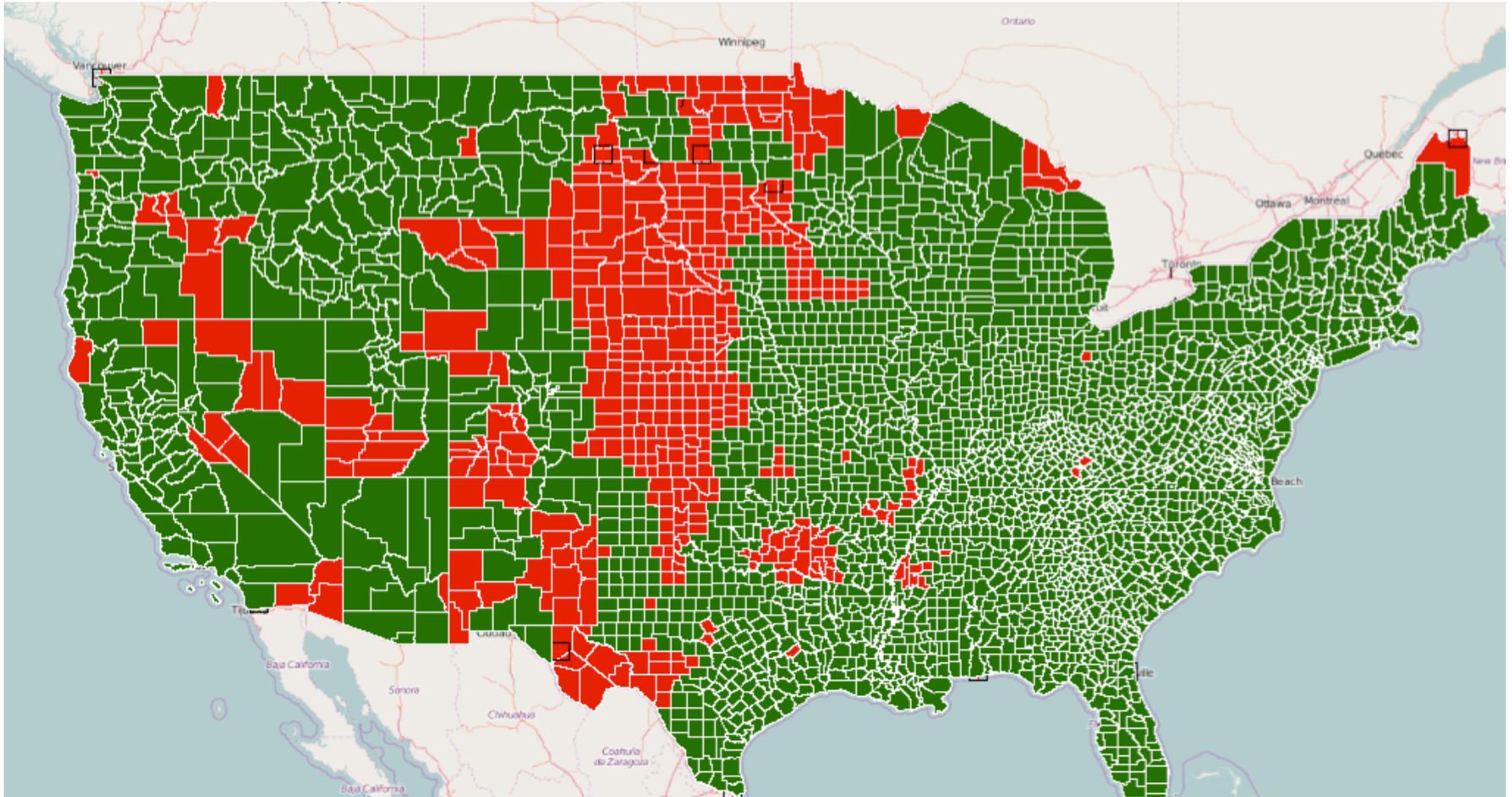


There are a sizable number of population centers that have infrastructure provided by small number of ISPs.

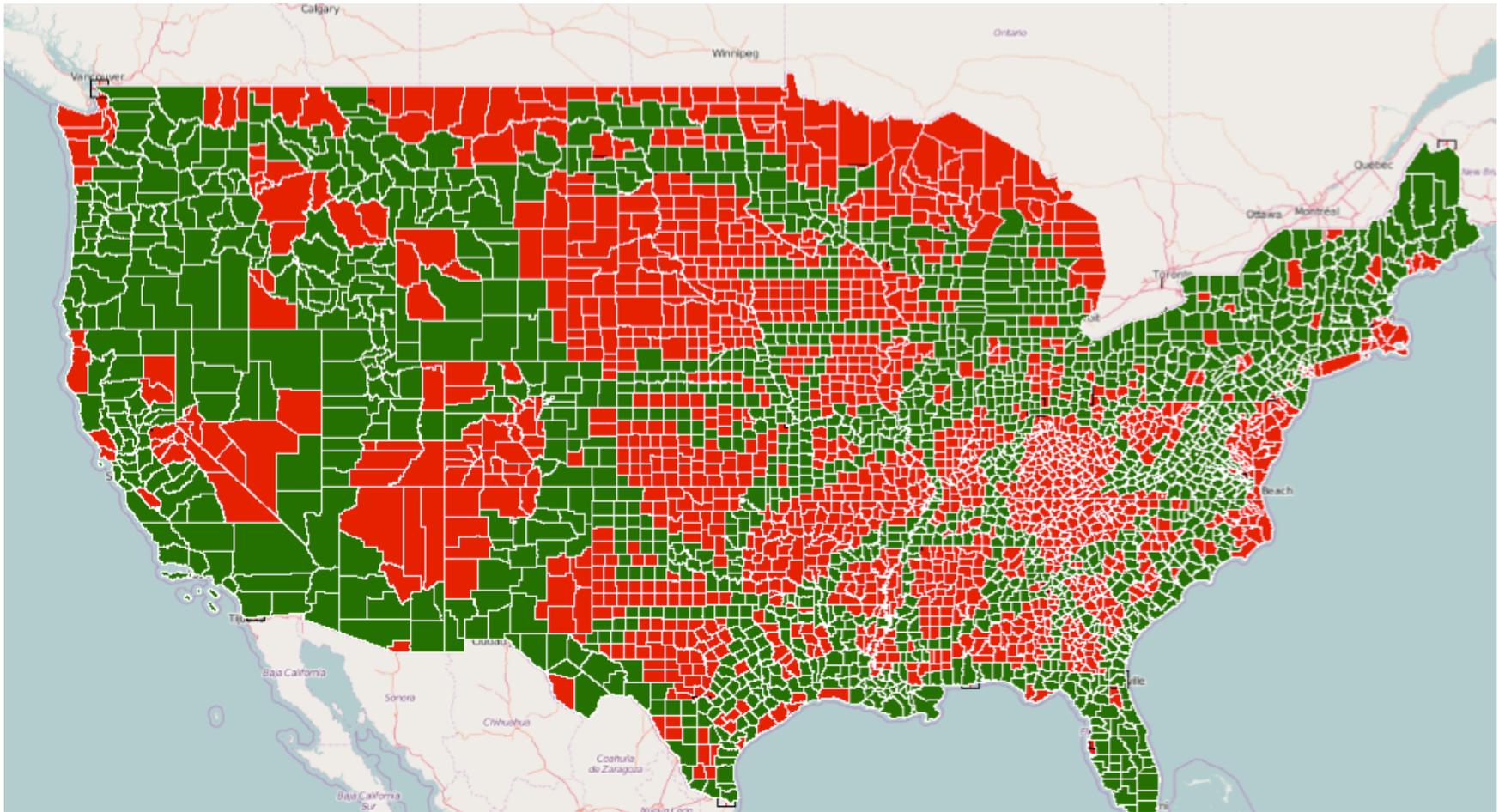
Availability of infrastructure

- We spatially integrate counties and infrastructure datasets
- Datasets
 - 100 US-based networks (Internet Atlas) (D1)
 - US long-haul data (InterTubes) (D2)
- Analysis using *spatial query* and *overlap* capabilities in ESRI ArcGIS

Availability of infrastructure (DI)



Availability of infrastructure (D2)



Talk outline

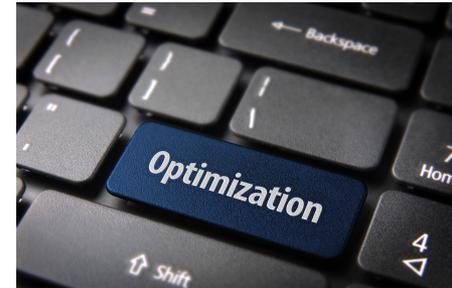
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Service provider objectives

- At a high level, no different than any other company – maximize shareholder value
- Grow revenues
 - Expand user-base
 - Expand service offerings (not considered)
- Minimize costs
 - Both CAPEX and OPEX
- Minimize risks
 - Both strategic and operational

Talk outline

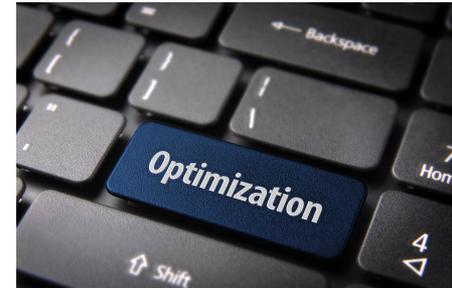
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A techno-economic approach

- Objective: a decision support framework for identifying broadband deployment targets
 - Can be applied to other deployment scenarios
- Framework considers
 - Infrastructure proximity
 - Demographics
 - Costs
- Identify the *highest* concentrations of un/underserved users and that can be upgraded to the broadband threshold at the *lowest* cost

Basic model

- *Quadratic assignment problem* – identify locations that maximize utility at minimal cost
 - We extend the Koopmans-Beckmann method of QAP
- Implemented in Python using the DEAP evolutionary computation framework
 - Objective – maximize # users in un/underserved areas
- Cost models
 - Upgrading existing PSTN infrastructure
 - New fiber deployment

Basic model

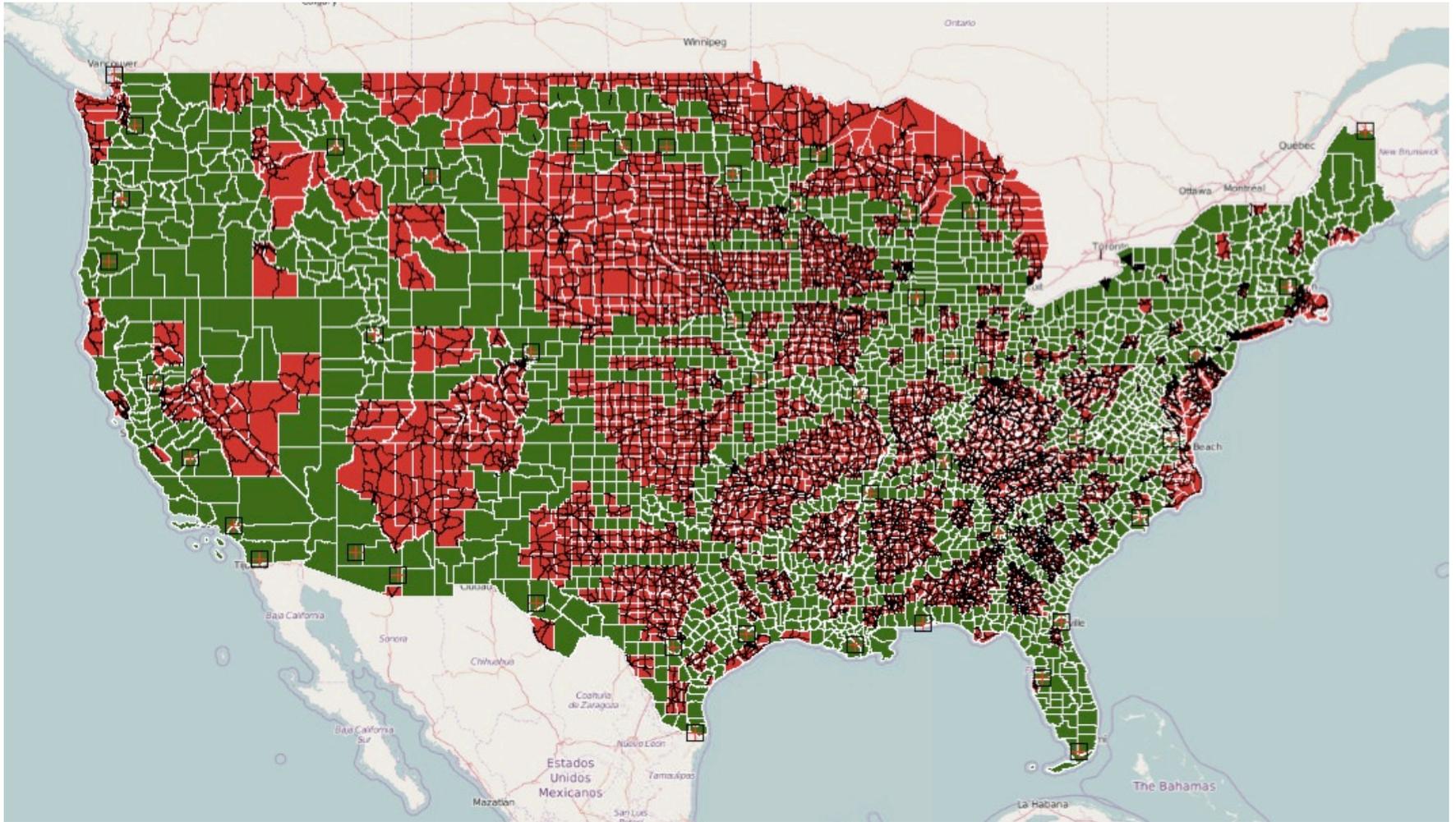
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 - **New fiber deployment**

More details
in paper!

New fiber deployment

- Deployments along the existing ROW
- Layer ROW data on top of infrastructure availability map
- *Spatial overlap* to find regions without any connectivity
- *Cost Distance* to find low cost spanning tree

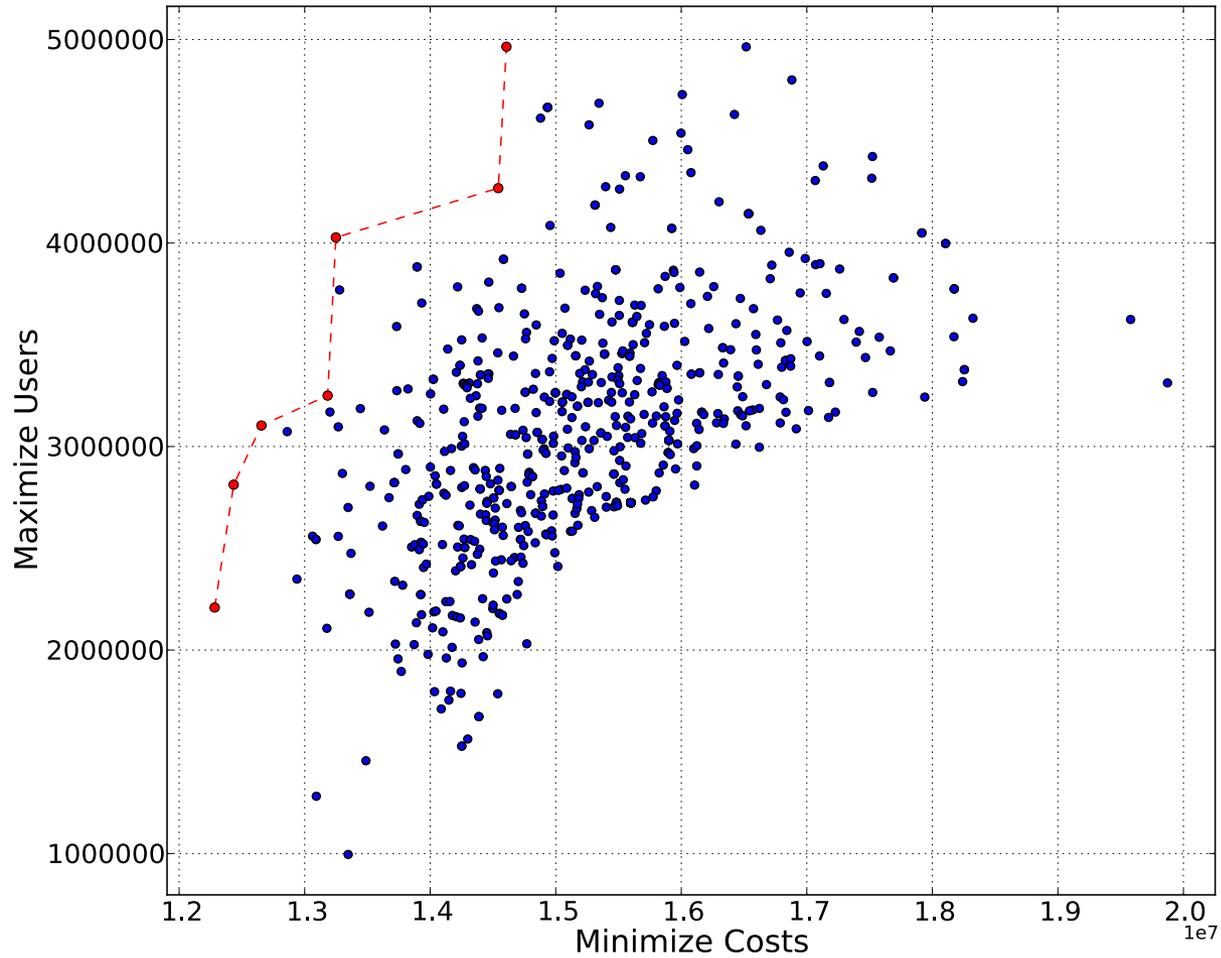
Infrastructure-aware deployment



New fiber deployment

- Deployments along the existing ROW
- Layer ROW data on top of infrastructure availability map
- *Spatial overlap* to find regions without any connectivity
- *Cost Distance* to find low cost spanning tree
- Finally, we apply our techno-economic framework to optimize costs further

Cost/benefit for new fiber deployment



Deployment targets

- Identified top 20 counties to
 - Maximize users
 - Minimize costs
- Counties in Texas, Wyoming, Dakotas were predominant
- Observation and target locations are consistent with *whitehouse.gov* report

Validation of deployment targets

- Percentage of agreement with FCC's Connect America Map
- Results
 - D1 agrees 92% with Connect America
 - D2 agrees 87% with Connect America
- Implications
 - Validates our framework
 - Connect America is progressing in the right way!

Final thoughts

- Expansion of broadband access is complex
 - Calls for a flexible decision support
- In this work, we identify targets by considering technical and economical issues in tandem
- Future work
 - Identify deployment targets in areas beyond US
 - Consider other business objectives
 - New market opportunities to maximize revenue

Thank you!

Contribute to our research with your infrastructure maps.

Visit <http://internetatlas.org>

Questions?