

# OVERCOME: A Systems Approach to Scaling Rural Co-op Efforts to Expand the Fiber Edge

**NWMO Broadband Discovery Group Update**

PI: Casey Canfield

Assistant Professor, Engineering Management & Systems Engineering

Missouri University of Science & Technology

[canfieldci@mst.edu](mailto:canfieldci@mst.edu)



We had 4 primary project goals.

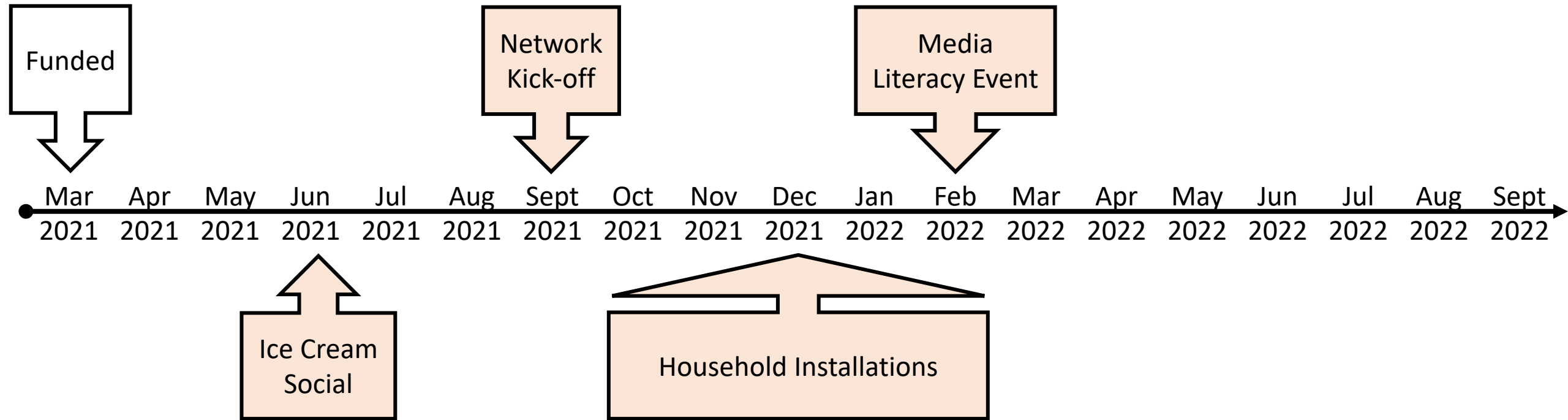
Connect  
households to  
network

Develop  
“intelligent  
router”

Evaluate  
impact of  
access

Document  
system

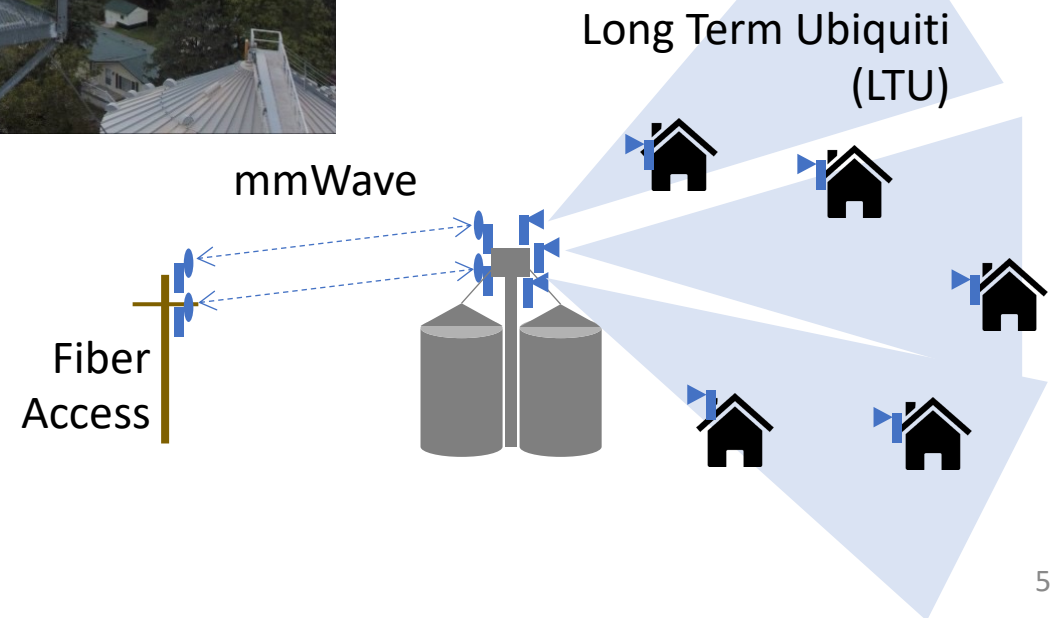
# Timeline



# United installed wireless broadband system.

## Performance Stats:

- Speed = >100/60 Mbps
- Latency = 6 seconds



# Community engagement supports recruitment and analysis.



## Integrating Research and Extension to Improve Community Participation in Broadband Projects

Casey Canfield, Sarah A. Low, Christel Gollnick, and Debra Davis

JEL Classifications: O18, L96, H54

Keywords: Broadband policies and programs, Community member involvement, Extension, Integrated research/Extension, Participatory research

With the passage of the bipartisan Infrastructure Investment and Jobs Act...

projects that further leverage Extension field and campus faculty relations to combine participatory research and evaluation methods as decision makers look to improve broadband programs in rural areas of their state.

## Using Participatory Methods to Improve Data Quality

Involving local participants can conceivably improve the quality of data collected as part of a ground-up approach to broadband program evaluation. However, participation also bias results by highlighting researchers' desired (Eckerd et al., 2021; Zizzo, 2010). Participatory evaluation builds on community-based participatory research principles as well as traditional evaluation techniques. It emphasizes improved communication and coordination with the local community and key stakeholders to improve experimental design, data



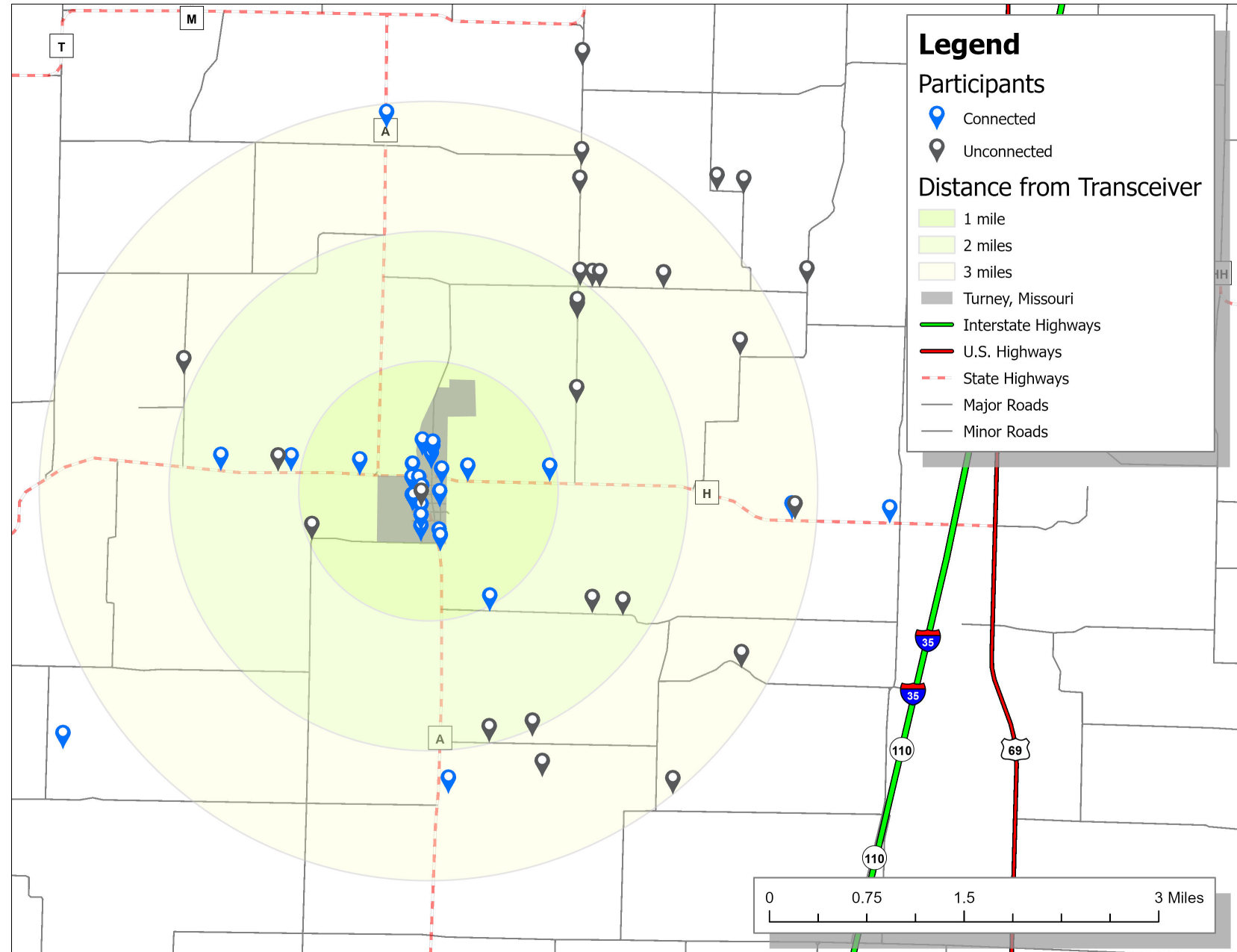
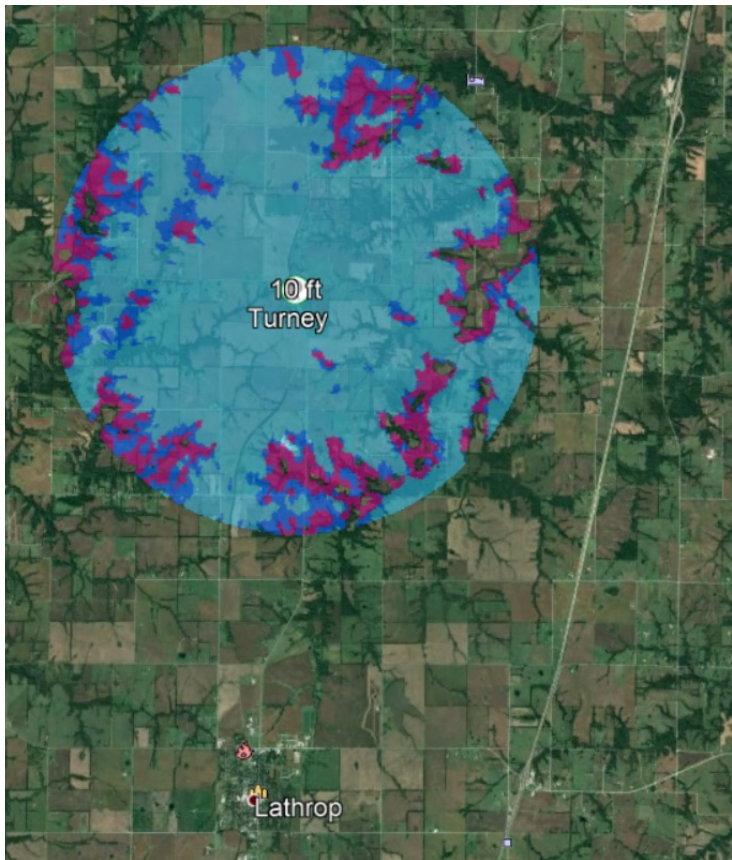
# Conducted media literacy outreach at 2 local high schools.



“It was a lot of good information on how to be **ethical users of the Internet** and digital media allies for each other by fact-checking before sharing emotional news that might not be real.” – Workshop Participant

Hosted by Kathy Kiely  
Lee Hills Chair in Free-Press Studies  
School of Journalism  
University of Missouri

Minimum Target:  
30 installations



# Wireless broadband has limitations but can serve as a medium-term solution.

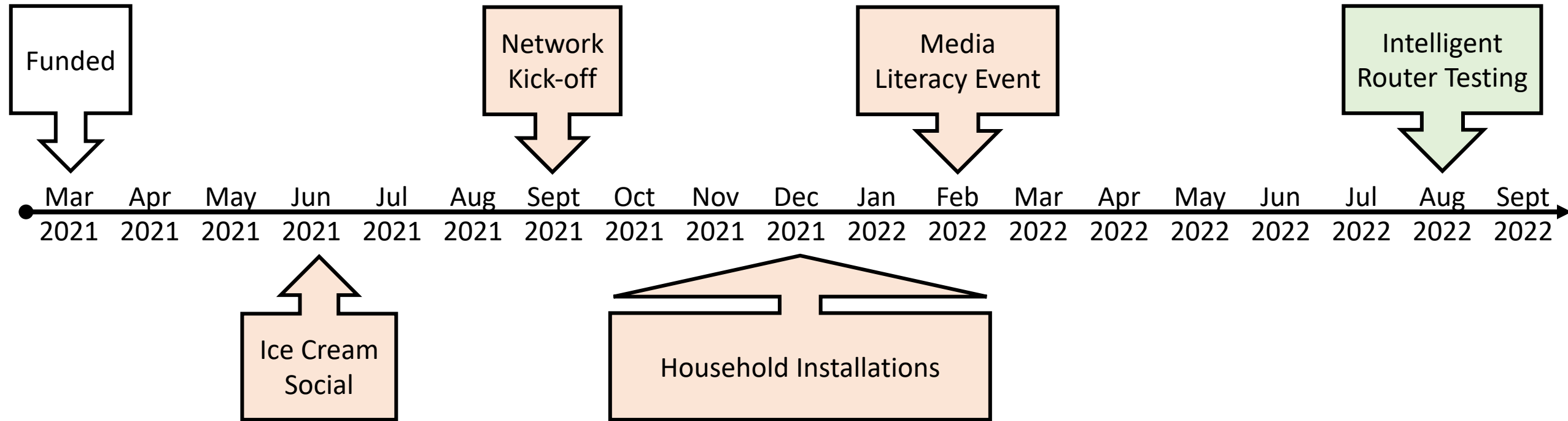
## **Barriers to Participation**

- Poor line of sight despite software estimates
- Dynamic competitive environment
- Previous negative experiences with wireless providers

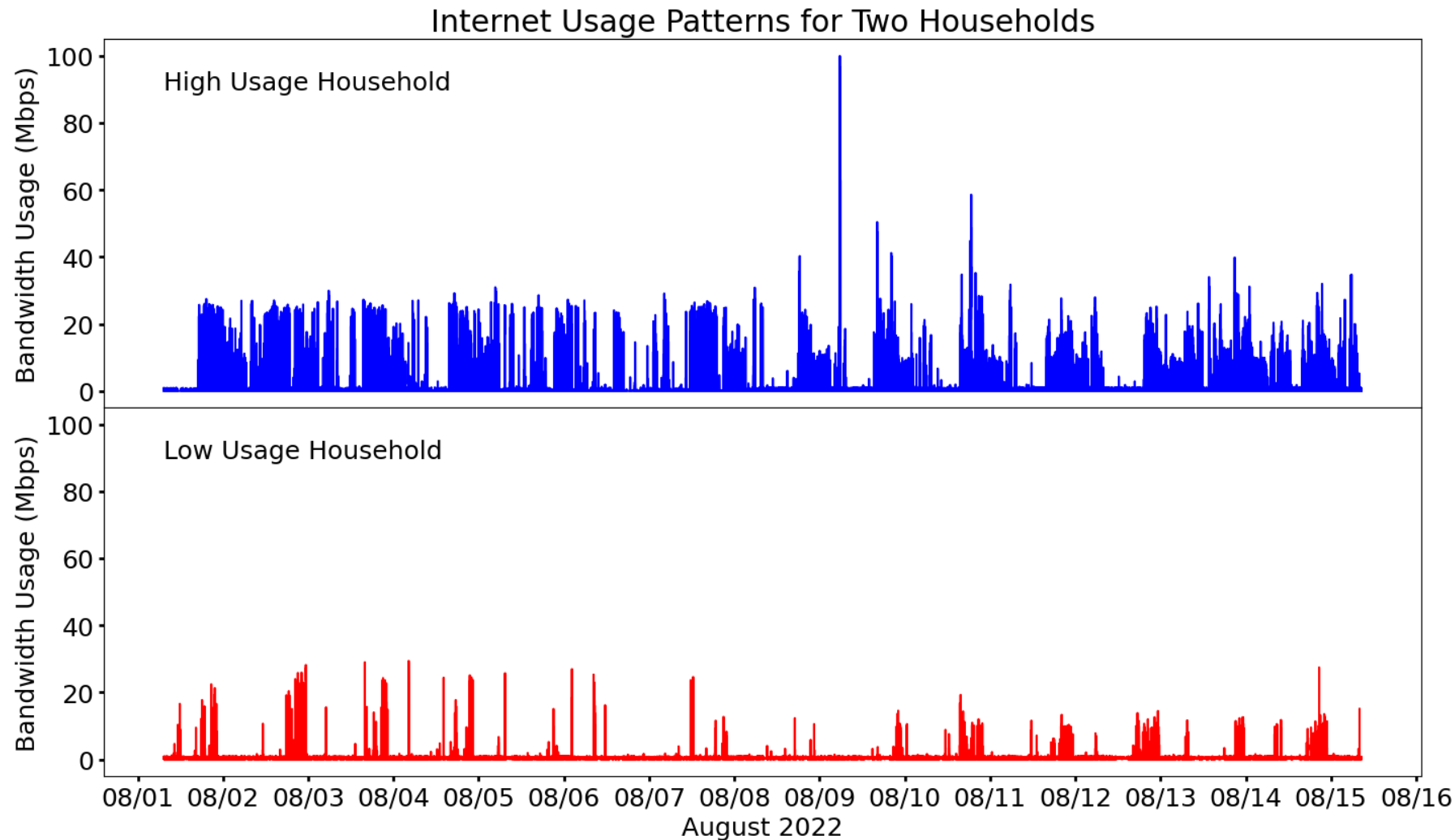
## **Challenges with Reliability**

- Rain (signal fade)
- Windstorm caused hardware damage (wire rubbing)
- Novel implementation
  - Hardware failures
  - Software errors

# Timeline



# There is high variability between users.



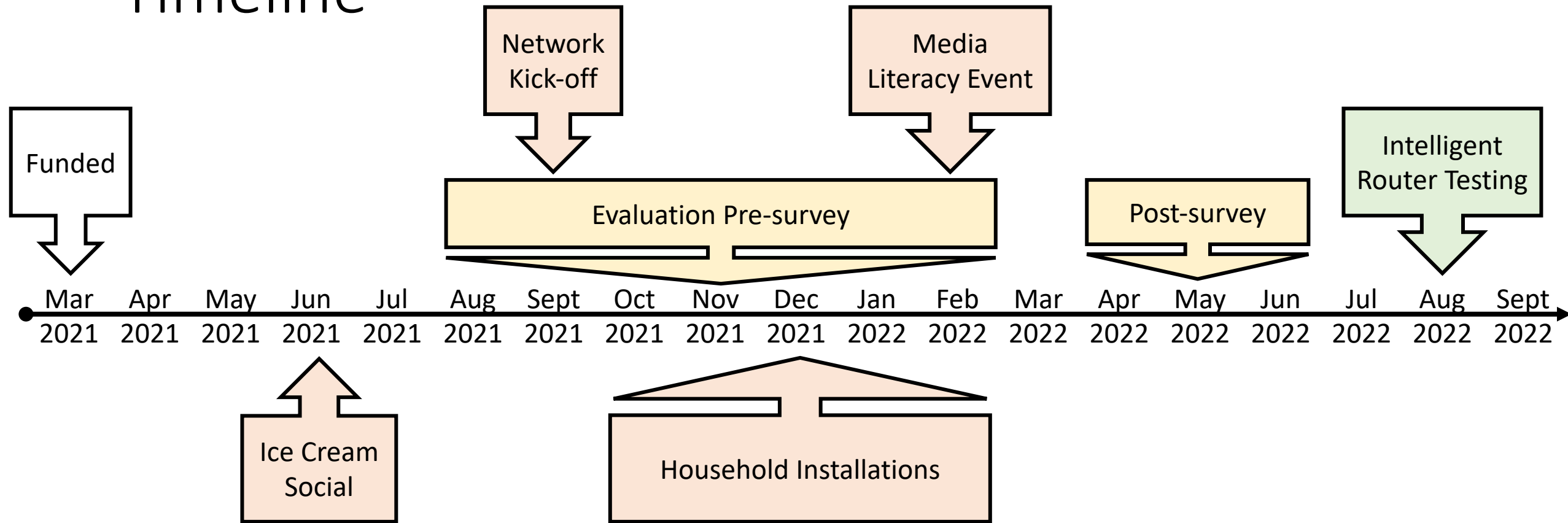
**Total Usage:**  
11-17 TB/month  
across all households

# Intelligent Router dynamically allocates bandwidth, worth further development.

- Created a simulation called the *Extendable Mobile Ad-Hoc Network Emulator (EMANE)* for development to avoid disrupting network
  - Real world data are critical for simulations
- Households were divided into 4 priority levels that updated every 10 seconds
  1. High Up/High Down
  2. Low Up/High Down
  3. High Up/Low Down
  4. Low Up/Low Down
- Need more testing to evaluate dynamic vs. static bandwidth cap
  - Data and code are available for open-source development

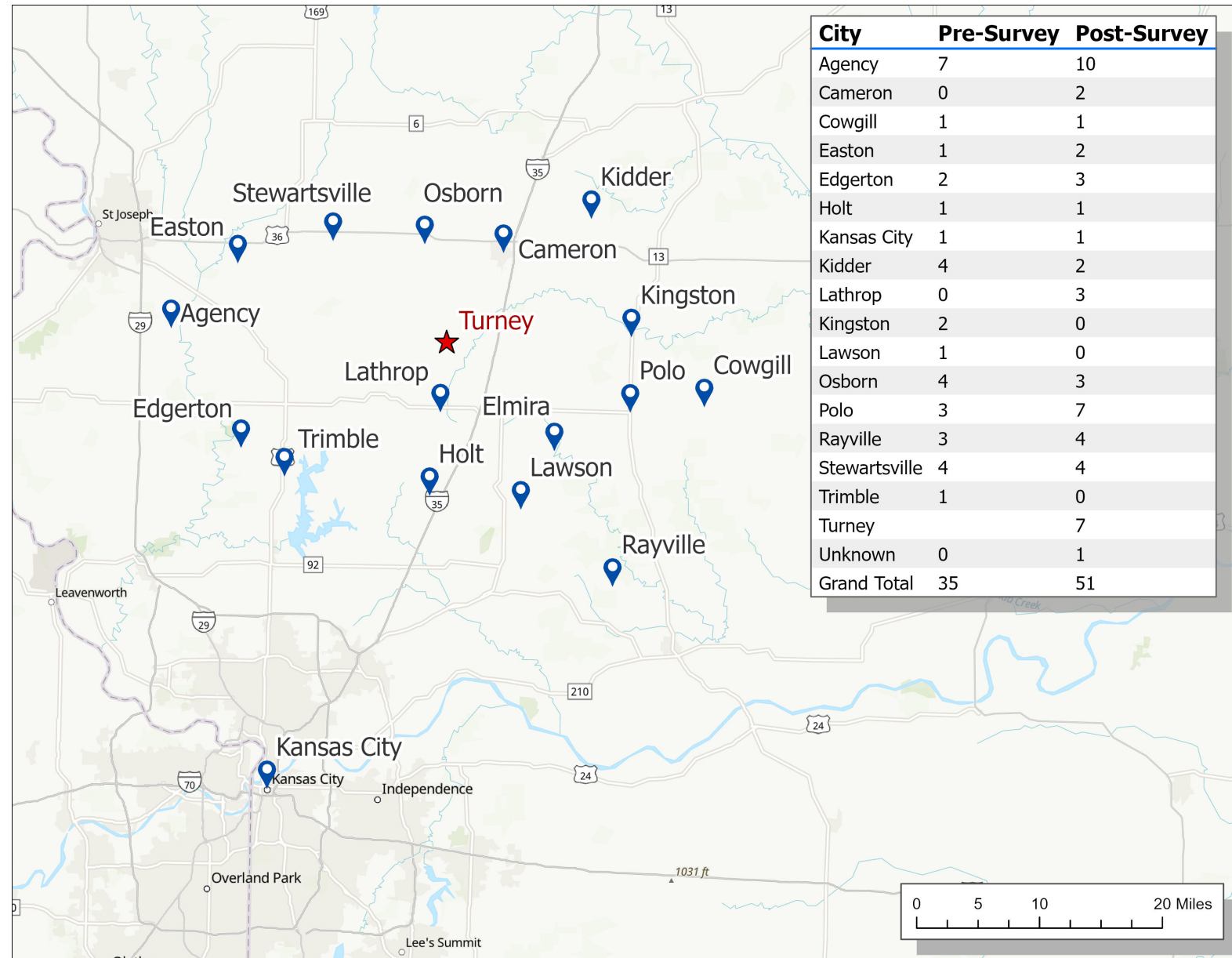
Priority 1 households temporarily borrowed bandwidth from Priority 4 households

# Timeline

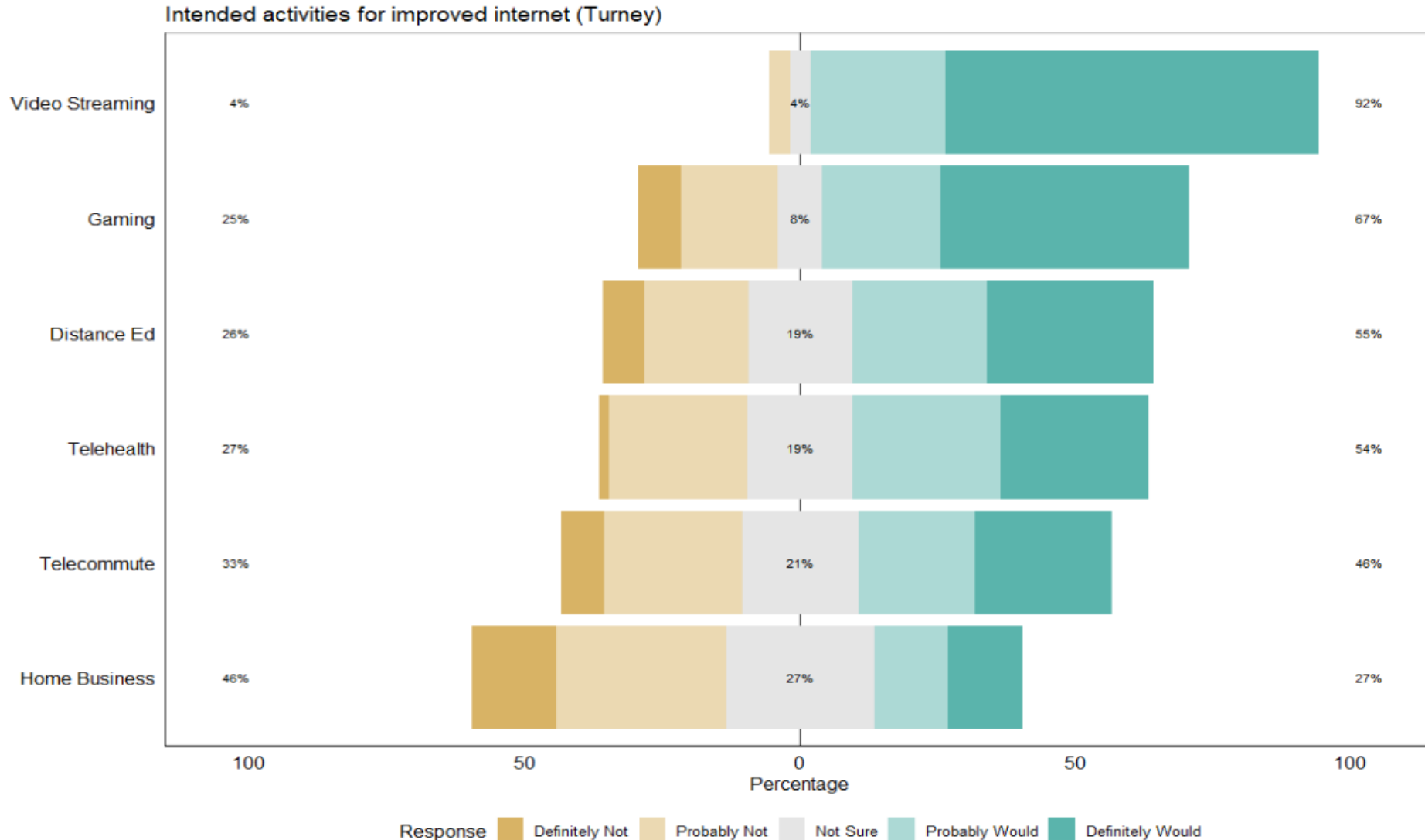


# Evaluation Design

- Making comparisons:
  - Pre-survey
    - Turney vs. Control
  - Post-survey
    - Connected Turney vs. Unconnected Turney vs. Control
  - Pre vs. Post
    - Connected Turney vs. Unconnected Turney
- Control group includes random sample from similar communities
  - Distribution in map



Turney residents were more focused on entertainment activities, than education, employment and health uses.



# The internet intervention provided benefits by increasing usage, rather than changing behavior.

## Employment

|                         |                                                                                                                                                                                                 |
|-------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| work from home          | "I am a teacher so I use the internet to create lesson plans daily. This program has allowed me to prep on the weekends from home."                                                             |
| search/apply for job    | "Perfect, always able to have connection to find jobs or have zoom interviews"                                                                                                                  |
| self-employment at home | "I have a small online business. I utilize social media platforms and etsy to advertise and sell my products. I've been able to post more and stay in contact with customers more efficiently." |

## Education

|                               |                                                                                                                                                     |
|-------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------|
| distance learning             | "My daughter also takes online college classes and she no longer has issues getting assignments submitted due to poor service."                     |
| homework at home              | "Grandson uses it for school."                                                                                                                      |
| search education-related info | "Watching more 'how-to' videos, in regards to cooking, fixing things, not really "higher" learning. Just more related to making one's life better." |

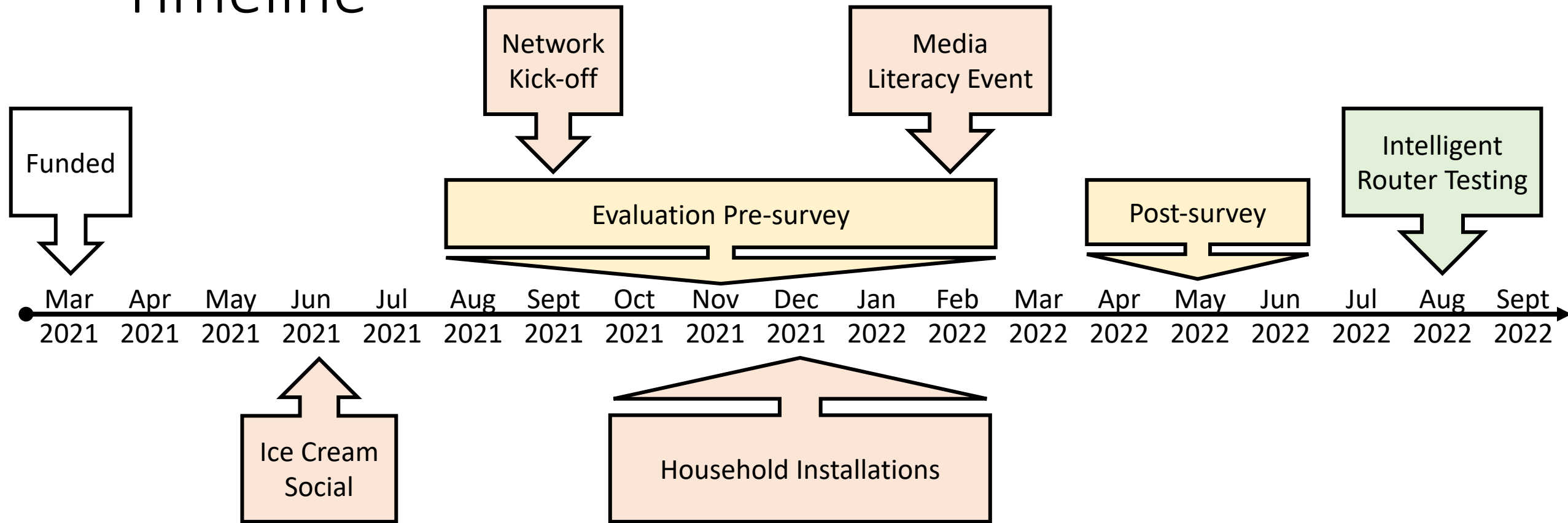
## Health

|                                |                                                                                                                                                                                                      |
|--------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| search for health-related info | "Look things up more about health than before."                                                                                                                                                      |
| telehealth                     | "We have been able to utilize the telehealth visit through our doctor's office. This has saved time and money. Less gas and not needing to take time off work to attend a face to face appointment." |
| use online patient portal      | NA                                                                                                                                                                                                   |

# Designing evaluations to measure impact for underserved communities is challenging.

- Changes in internet usage for employment, education, and health could not be attributed to internet intervention
  - Limited by short timeline
- Benefits were more related to entertainment uses and increasing existing use
  - Entertainment use is critical for quality-of-life
- Limitations
  - Challenges related to recruitment and timing of the survey
  - Reliability issues likely limit the impact of wireless technologies

# Timeline



# Reference architectures can support project development and dissemination.

- In other domains, reference architectures are an abstract representation of a system that can support communication and reduce design time/costs
  - can help diverse stakeholders understand “the problem” and agree on requirements for a solution
- For each project, you can fill in the reference architecture to generate a solution architecture

# Community-Driven Wireless Broadband Reference Architecture

## User Profile

Reflects Needs and Constraints

### Constraints & Opportunities

Geographic (natural capital)  
Technological (physical capital)  
Economic (financial capital)  
Demographic (human capital)  
Regulatory

### Needs Assessments

Internet Use  
Affordability

Describes  
Community

Determines  
Solution  
Space

## Future Work

- Operations Structure
- Market Structure

## Community Structure

Reflects Human Infrastructure Parameters

Community is made of

**Households** which are made of

Adults and/or Children who use the internet for  
Education/Health/Work/Leisure

**Industry** provides employment and uses the internet for Work

**Governance** determines rules and regulations

**Resources** support internet use adoption (social capital)

Banks

Utility

Community Collectives

Healthcare

Education

## Technology Structure

Reflects Technology Infrastructure Parameters

**Middle Mile** provides a connection to the internet via a Connection Type  
and Ownership Model

**Last Mile Solution** is made of

**Router** which manages internet data flow

**Transceivers** which transmit and receive information from the  
Middle Mile or  
Nodes

**Nodes** which are households and businesses that receive internet  
service

# Thank You!

[https://www.maximizenwmo.org/  
broadband-project-overcome](https://www.maximizenwmo.org/broadband-project-overcome)

Casey Canfield, Assistant Professor  
Engineering Management &  
Systems Engineering

Missouri S&T

[canfieldci@mst.edu](mailto:canfieldci@mst.edu)

