



# Scaling the Seattle Community Network with dAuth and the “Teaching Network”

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# With Partners

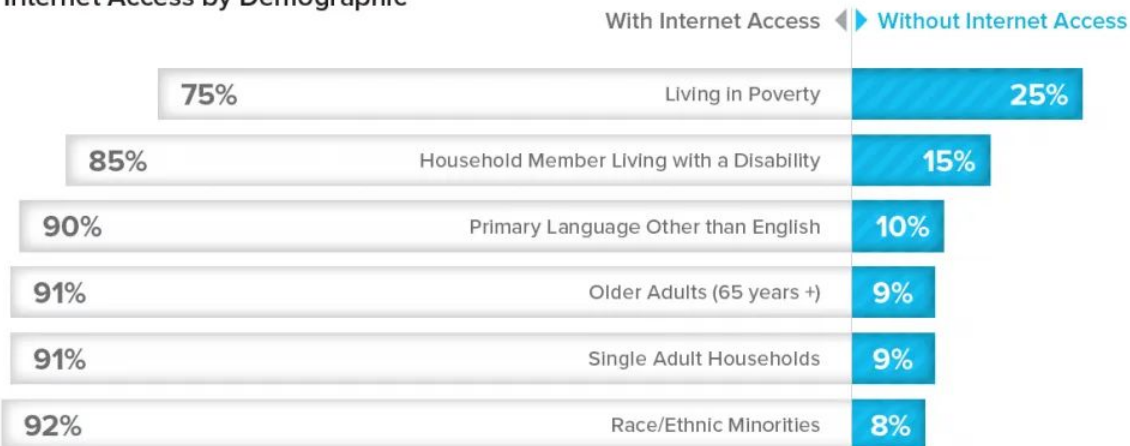


A photograph of the Seattle skyline at dusk or dawn. The Space Needle is the central focus, with its distinctive saucer top. The city's skyscrapers are visible in the background, some with lights on. The sky is a mix of dark blue and light orange. The text is overlaid in the center in a large, white, sans-serif font.

95% of Seattleites have  
access to the Internet



## Internet Access by Demographic



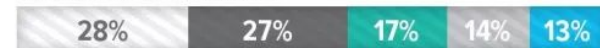
## Online Activity Levels: By Impacted Groups

Low 
  Med Low 
  Medium 
  Med High 
  High

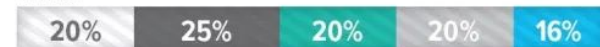
Children in Household



No Children in Household



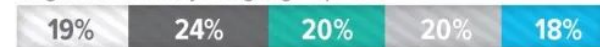
White



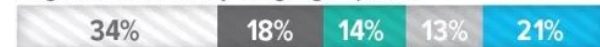
Minorities



English as Primary Language Spoken



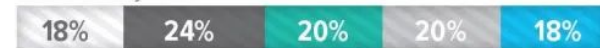
English is not Primary Language Spoken



Disability in HH



No Disability in HH



Under 65 years of age



65 years of age and older





# Seattle Community Network

The Seattle Community Network is working to build free/low-cost access networks throughout the city.

Trying to connect people who...

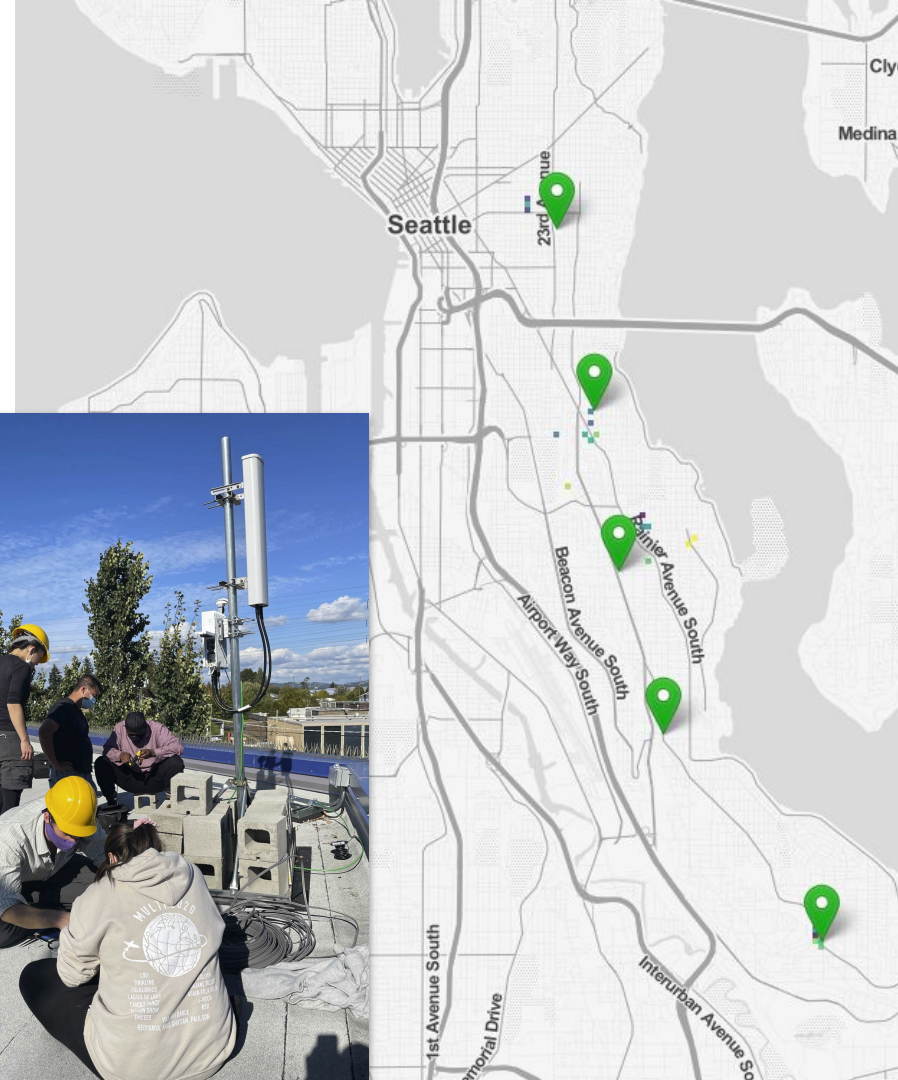
- **can't afford** to pay for their own access networks (e.g. pay Comcast bill)
- **can't afford** to purchase user devices (e.g. laptop, phone)
- **don't know how** to connect to access networks
- Currently **free** for *Seniors, Unemployed, Housing-unstable, majority non-English-speaking, low-income families of students*
  - **for others, suggested-donation cost** based on income



# Current Site Locations

- Filipino Community Center
- Garfield HS in Central District
- Franklin HS in Mt. Baker area
- Oromo Cultural Center
- Skyway Library
- SURGETacoma (Tacoma)
- Tacoma Public Library Main Branch

[Map on our website](#)



# External Technical Elements

Community Cellular Networks have traditionally been stymied by a variety of technical and policy issues outside of operator control. These have been largely resolved by recent advances in private networks:

1. Quality cellular spectrum has been unavailable for small operator use
  - > **CBRS has been live since April 2020**
  - > **GAA Spectrum readily available in our region**
2. Equipment has been expensive when compared to similar wifi gear
  - > **Inexpensive LTE/NG gear is available from a variety of small-scale vendors (e.g., Baicells, Cambium, etc)**
3. Others/Etc.





# Technical Vision

We want to **empower** community-facing organizations to **connect their communities** they care about but...

These community organizations generally **do not want to be ISPs**. They want to connect their community and that's all. This makes scaling hard.

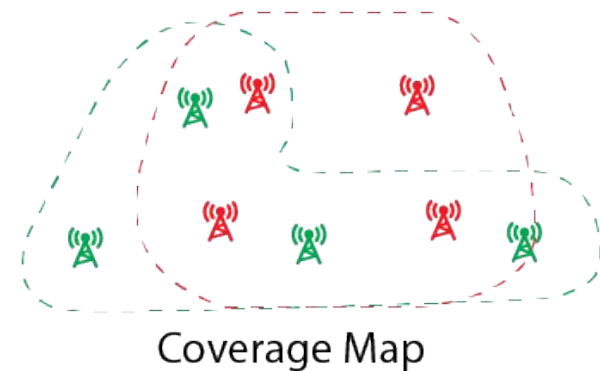
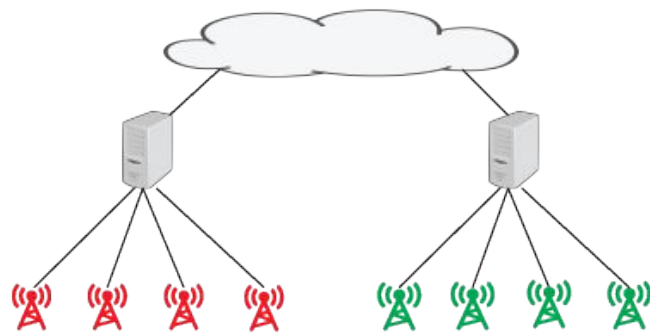
As a solution, we aim to scale horizontally (adding more network partners) rather than vertically (making networks bigger).

We do this by developing a stock UE-compatible **federated** core network that allows multiple small community cellular sites to **partner together** to provide wide-area coverage.



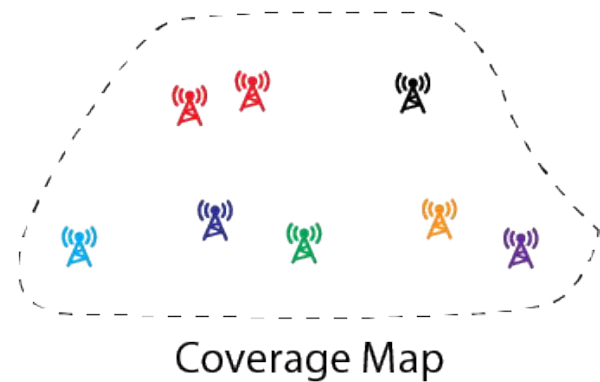
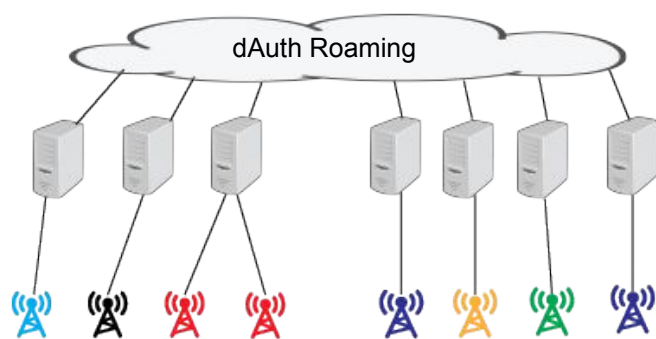
### Traditional MNO

Interconnect  
Core ( $N < 10$ )  
RAN ( $N > 10^4$  per NW)

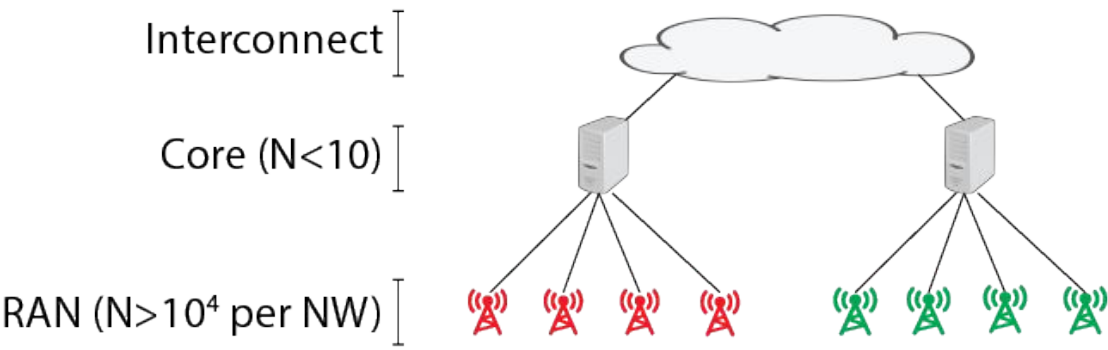


### Cooperative Cellular

Interconnect  
Core ( $N > 10^4$ )  
RAN ( $N < 10$  per NW)



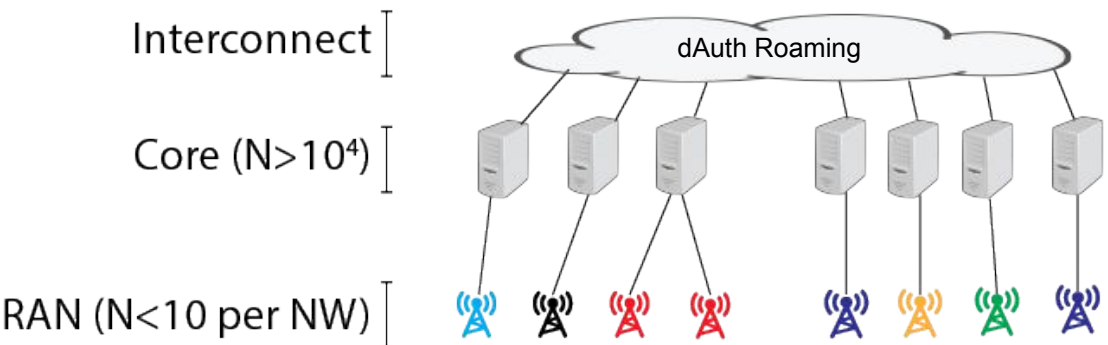
### Traditional MNO



### Competing coverage



### Cooperative Cellular

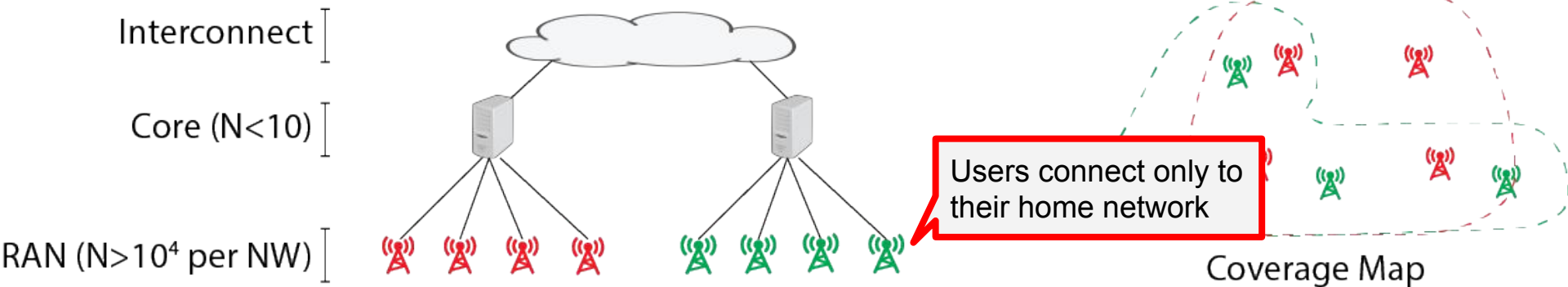


### Cooperative coverage

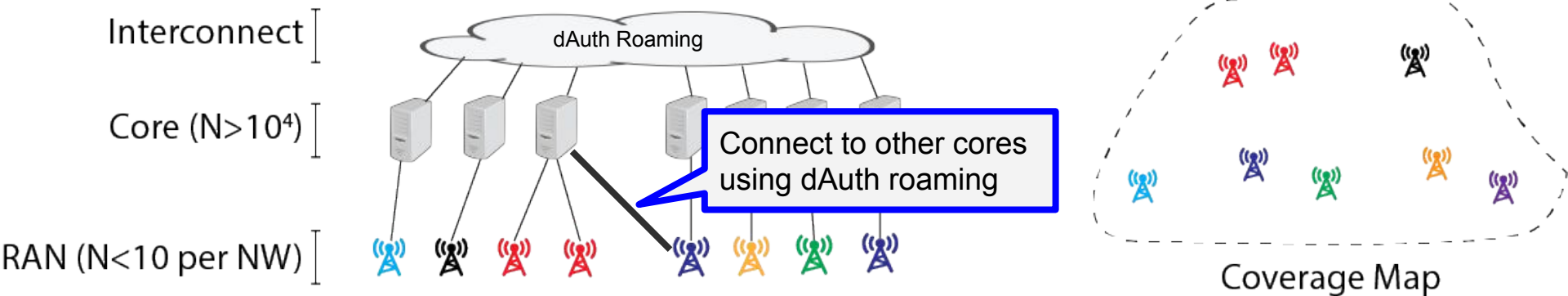




### Traditional MNO



### Cooperative Cellular



# dAuth Roaming

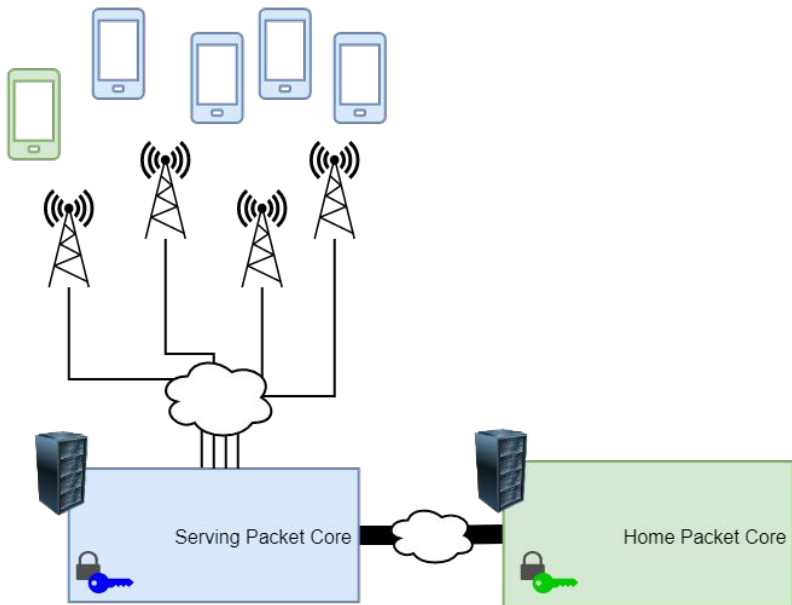
Our roaming solution must allow for users to move between various community nodes while also meeting the following needs of allowing more CN partners:

1. Tolerating temporary failure of a subset of nodes (partner organization networks) without losing liveness or safety of the overall system.  
***“Community Infrastructure can be less stable”***
2. Tolerating the presence of malicious nodes outside the user's home network without compromising the user's security.  
***“We can't share critical network state (e.g., IMSIs/Kis)”***
3. Operating with existing off-the-shelf hardware built for standardized 4G and 5G networks and without requiring a system-specific upgrade from the manufacturer.  
***“Communities must use inexpensive commodity devices”***



# Traditional Roaming

Traditional cellular roaming



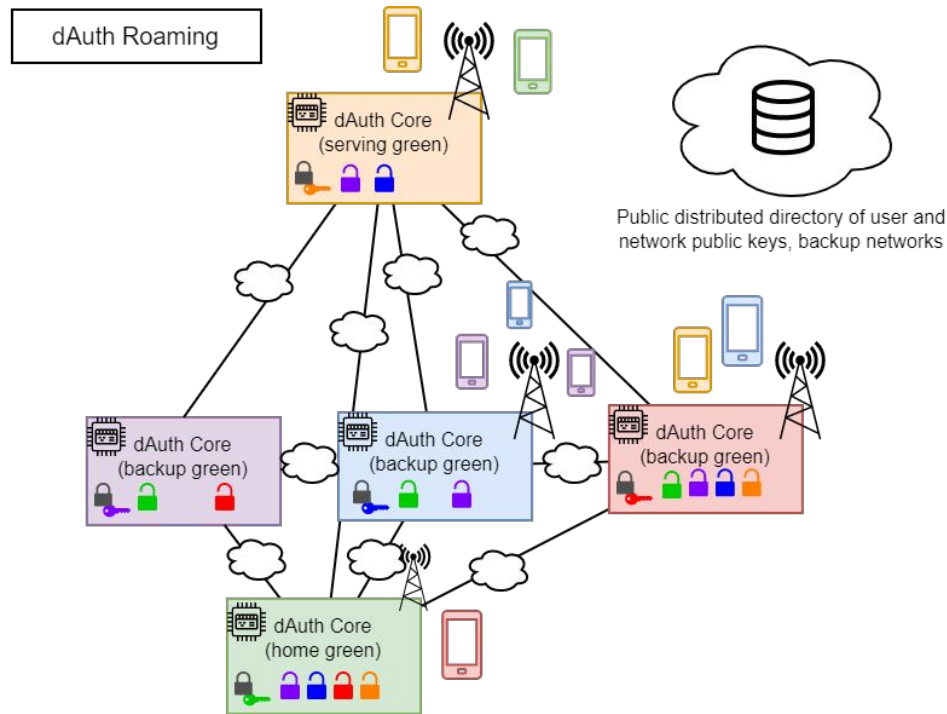
- Large centralized “core”
  - 100ks of subscribers
  - **Enormous** hardware
- Keys stored in home network
  - Auth requires network traversal

**Key point:** This doesn't work for small community networks



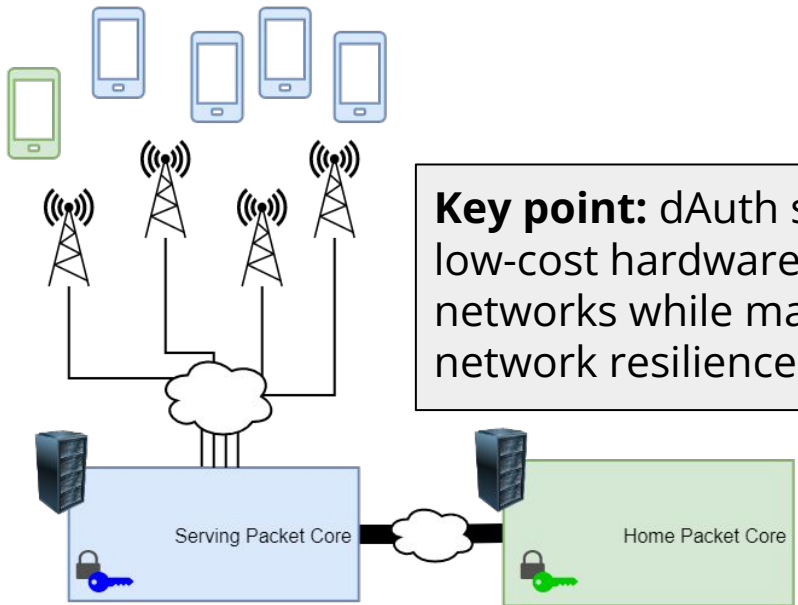
# dAuth Roaming

- Many small “core” networks
  - One for each partner
  - Tens of subscribers
  - Run on low-cost edge hardware
- Nearby peers cache auth info
  - “Authentication Vectors”
  - No private info
  - Allows graceful failover
- Public distributed directory of networks



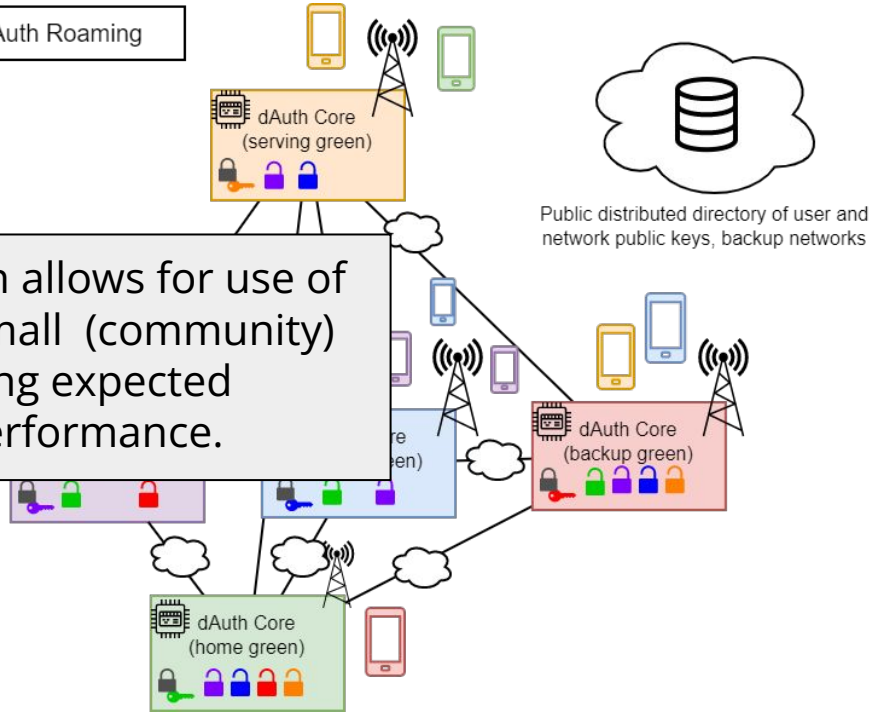
# Architecture Comparison

Traditional cellular roaming

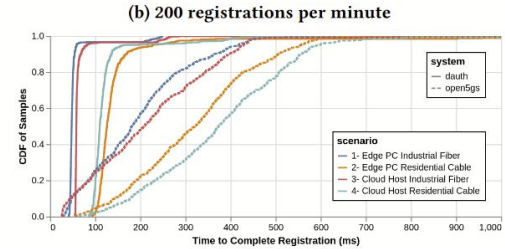
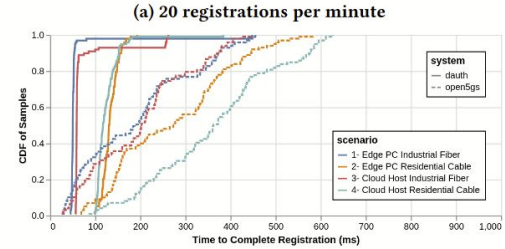
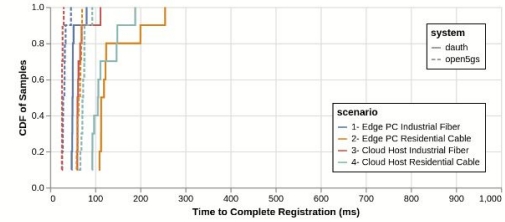
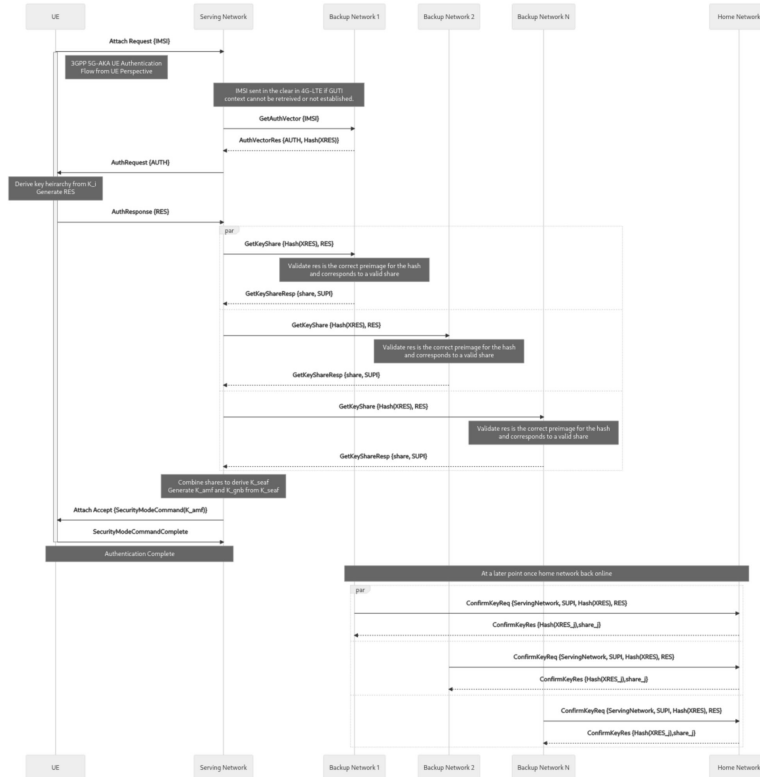


dAuth Roaming

**Key point:** dAuth solution allows for use of low-cost hardware and small (community) networks while maintaining expected network resilience and performance.



# dAuth Evaluation Handwaving



(c) 1000 registrations per minute

# Opportunities for Social Impact

## Internet Service *and...*

- **Service learning** for students and tech workers
  - Community educational workshops: "Hack Nights" and ("DiscoTechs")
  - Community IT/Tech Support
- **"Digital Stewards"** Youth and Adult vocational training program

## Seattle Community Network Presents...

How Does the Internet Really Work?  
and how to build your own internet for your local neighborhood



**Sunday, July 10**  
**1-3pm**

*repeated on*

**Tuesday, July 12**  
**4-6pm**

**Skyway Library**





# Digital Stewards

- Youth and Adult versions
- **Hands-on computing education** and **job training** towards collaboratively building and maintaining a community network
  - **Internet infrastructure**
  - Intro to coding/command line
  - **Principles of networking**
  - Configuring radios, building Ethernet cables
  - **Community organizing;** designing with community stakeholders

Digital Stewards- Wi '21



Youth Digital Stewards-  
Fall '21 - Wi '22





# SCN as a “Teaching Network”

- Provides **free and low-cost Internet service**
- Connects UW students and tech workers with broader Puget Sound community, **opening up the “bubble”**
- A resource for **building regional capacity** in ISP-level network operations, training, and practice
- **Community of practice**

Connect WA  
Broadband  
Technician class  
perform SCN site  
survey in South  
Seattle ->



UW students  
perform SCN  
coverage  
test at a  
Tiny Home  
Village ->



<- SCN  
volunteers  
teach at Tribal  
Broadband  
Bootcamp 2021



# Concluding Thoughts

- dAuth not yet in prod; expected in near future
  - SCN network for evaluations and lab trials
- However, the teaching material is well-tested and available
  - But always under active development
- Everything we do is produced in open source
  - <https://github.com/uw-ictd/>

Always taking donations at:  
<https://seattlecommunitynetwork.org> !



NEW AMERICA



Thanks!

[kheimerl@cs.washington.edu](mailto:kheimerl@cs.washington.edu)

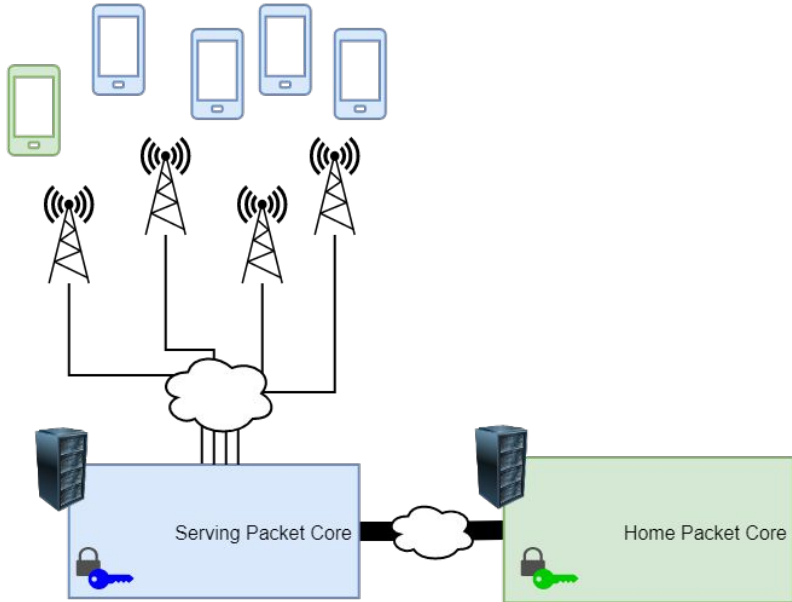
<https://kurti.sh>

BURK



# dAuth Roaming Architecture

Traditional cellular roaming



dAuth Roaming

