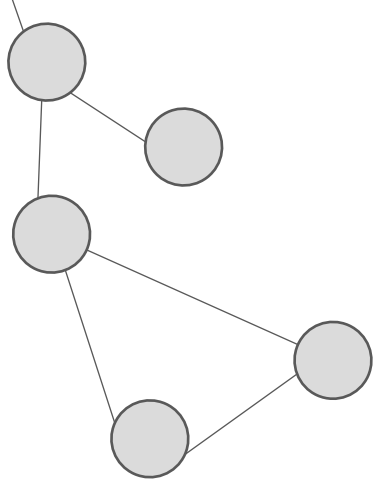
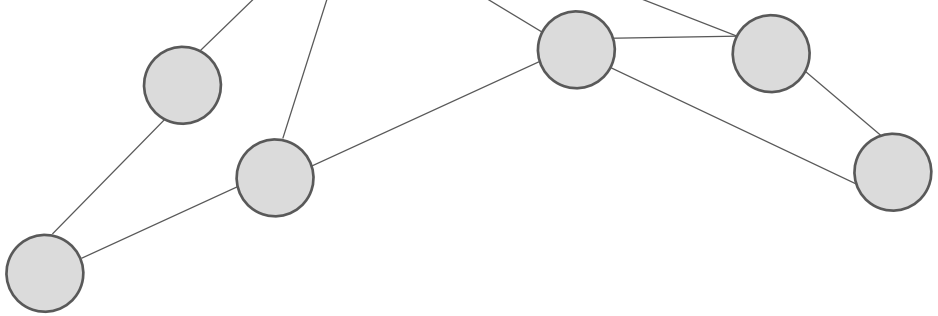
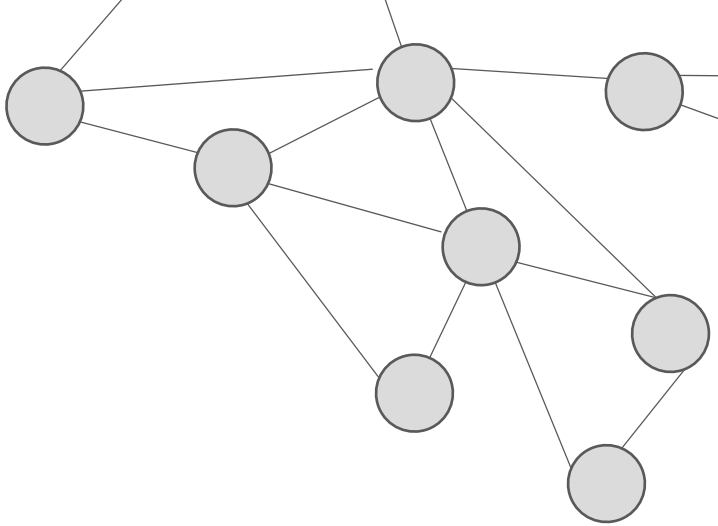
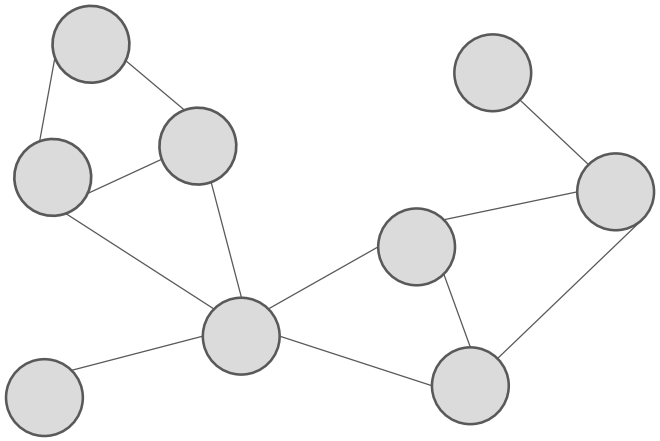
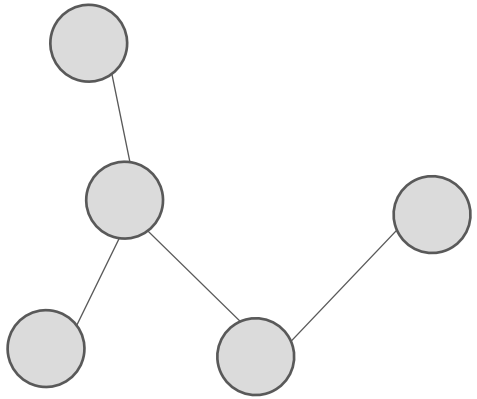
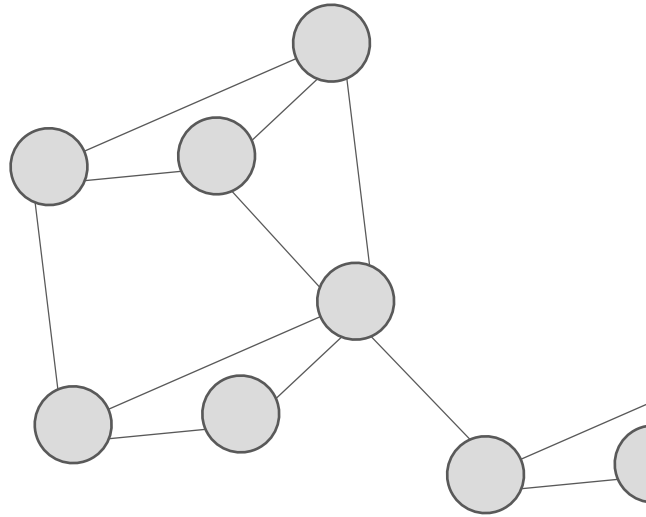




# Peer3Peer

## Disaster Proof Offline Messaging

Simran Arora, Jenna Barton, Ben Judd, Ramya Rao, David Wang

Advised by Dr. Vincent Liu

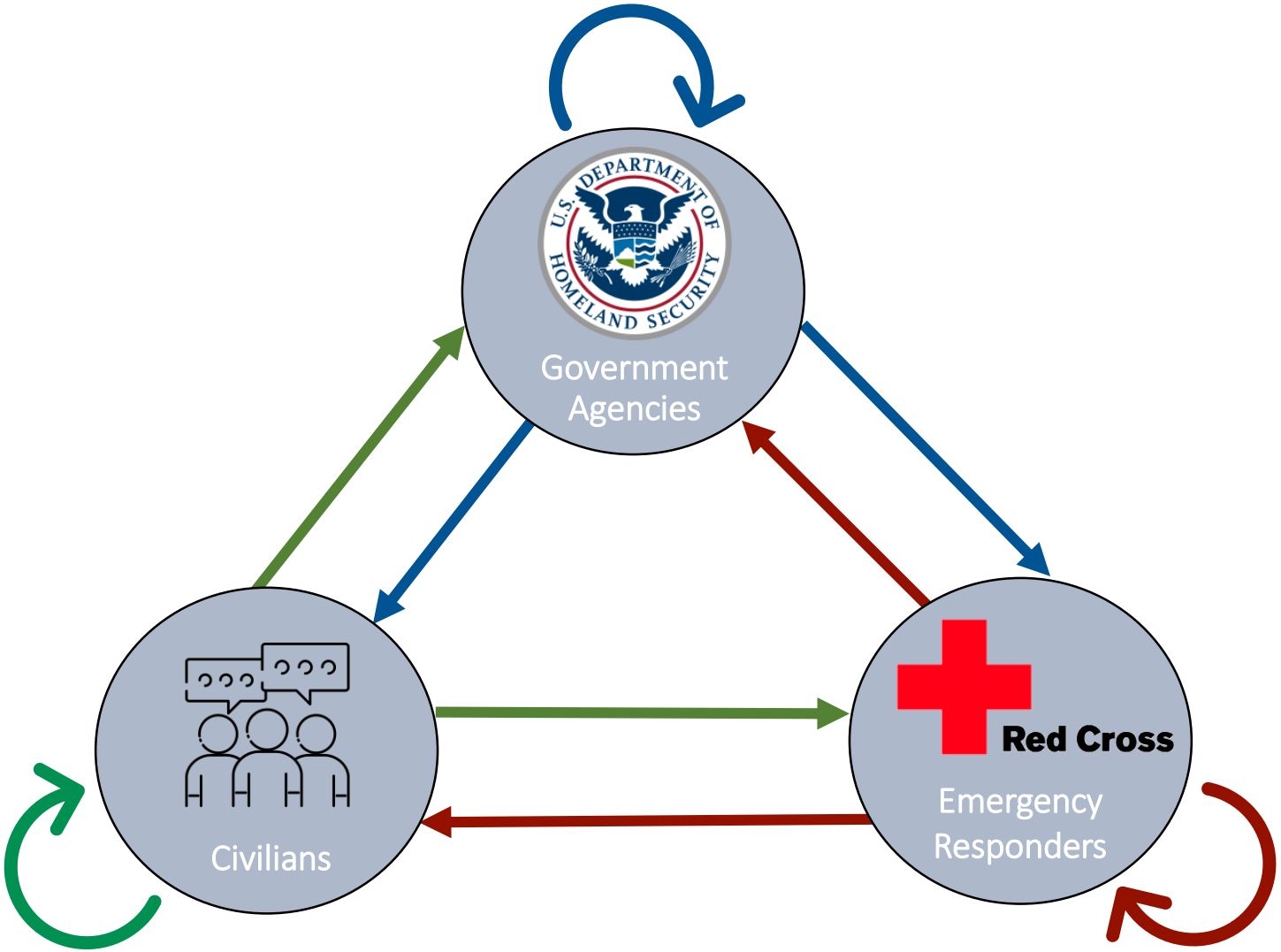




Hurricane Katrina (60%)

California Wildfires (55%)

Hurricane Michael (29%)

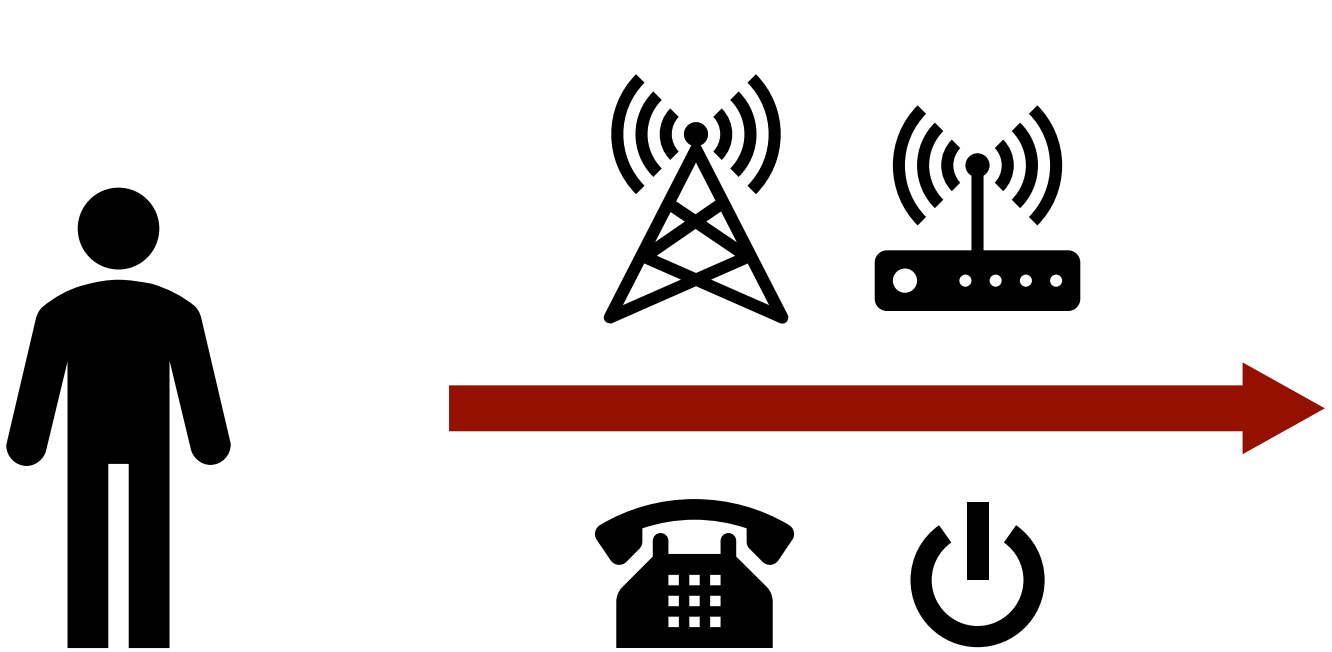
# Communication in Disasters

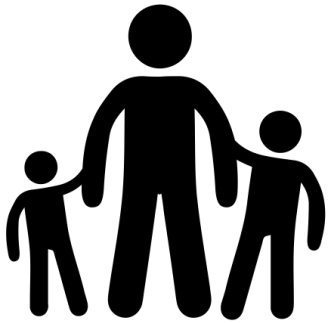



**153M** people affected globally per year

**Hundreds** of aid organizations involved in each recovery process

# Connectivity is lost when needed the most.

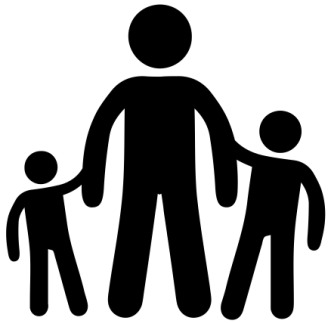




Family

Emergency Personnel

# Connectivity is lost when needed the most.



Family

Emergency Personnel

# Case Study: Puerto Rico

Connectivity during the aftermath of Hurricane Maria

# Puerto Rico goes dark.

The storm affected critical communications infrastructure impacting health and safety, law enforcement, ATMs and banking, business continuity, and more…

**95%**
cell towers offline

**47%**
citizens still lacked power after 1 month

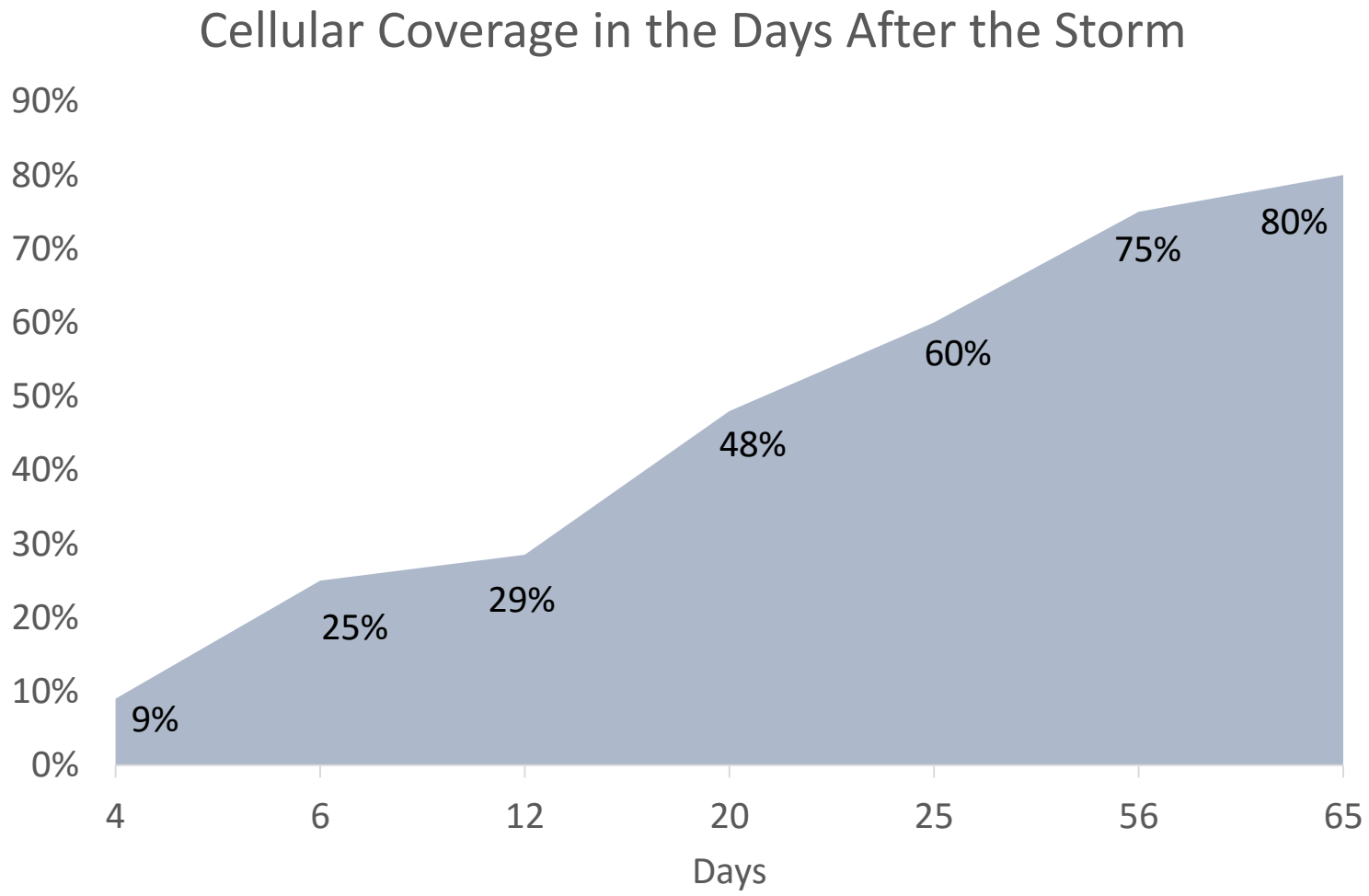
**85%**
telephone & internet cables destroyed

"Acertainment of the Estimated Excess Mortality from Hurricane Maria in Puerto Rico." The George Washington University.[1]

# Aftermath

"A caller to [a] radio station had cried out, "Help—my house is filling up with water!" before the line went dead."

975
deaths due to lacking communication

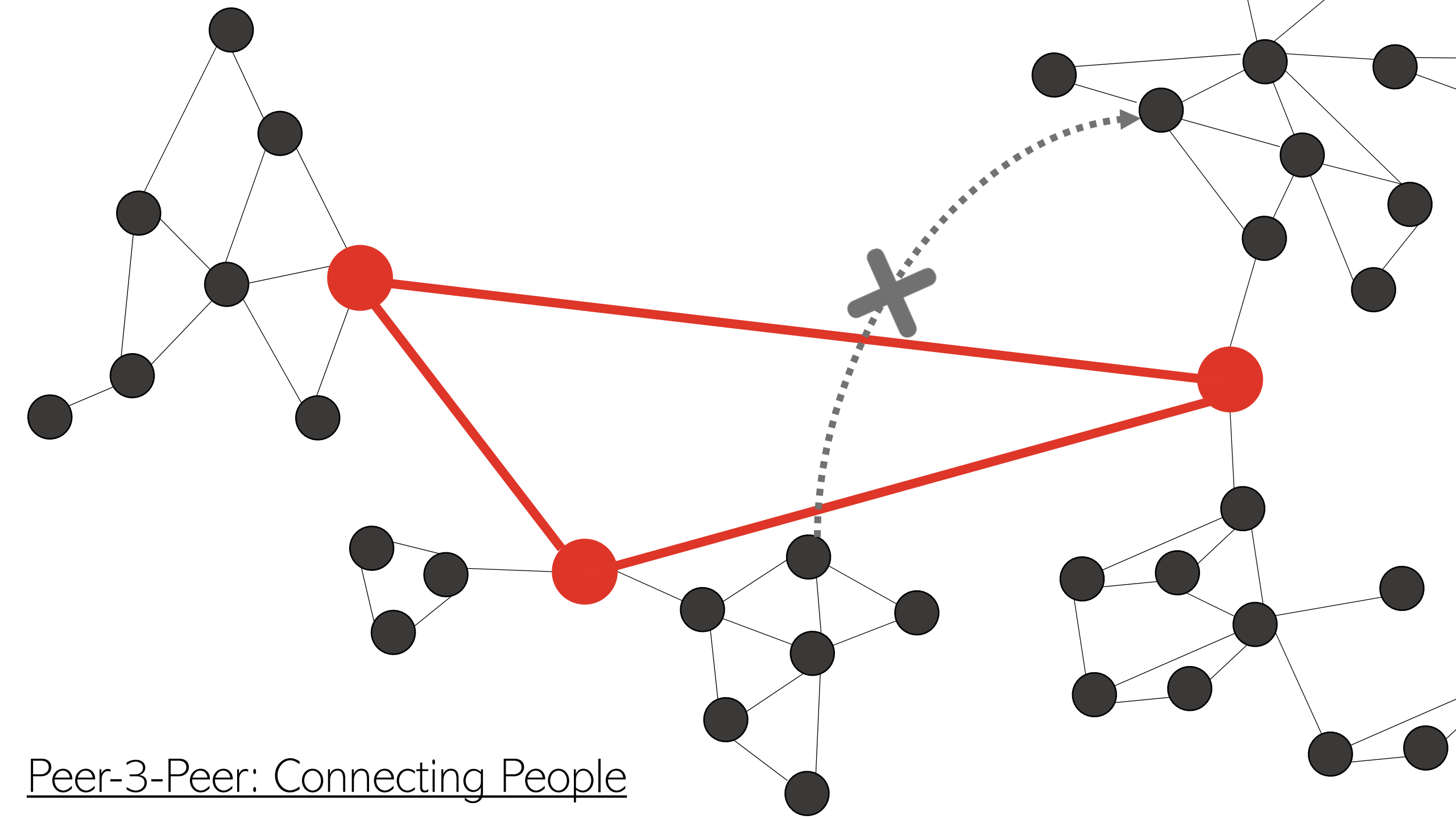


# Peer-3-Peer Chat

Extending peer-to-peer communications with hardware radios

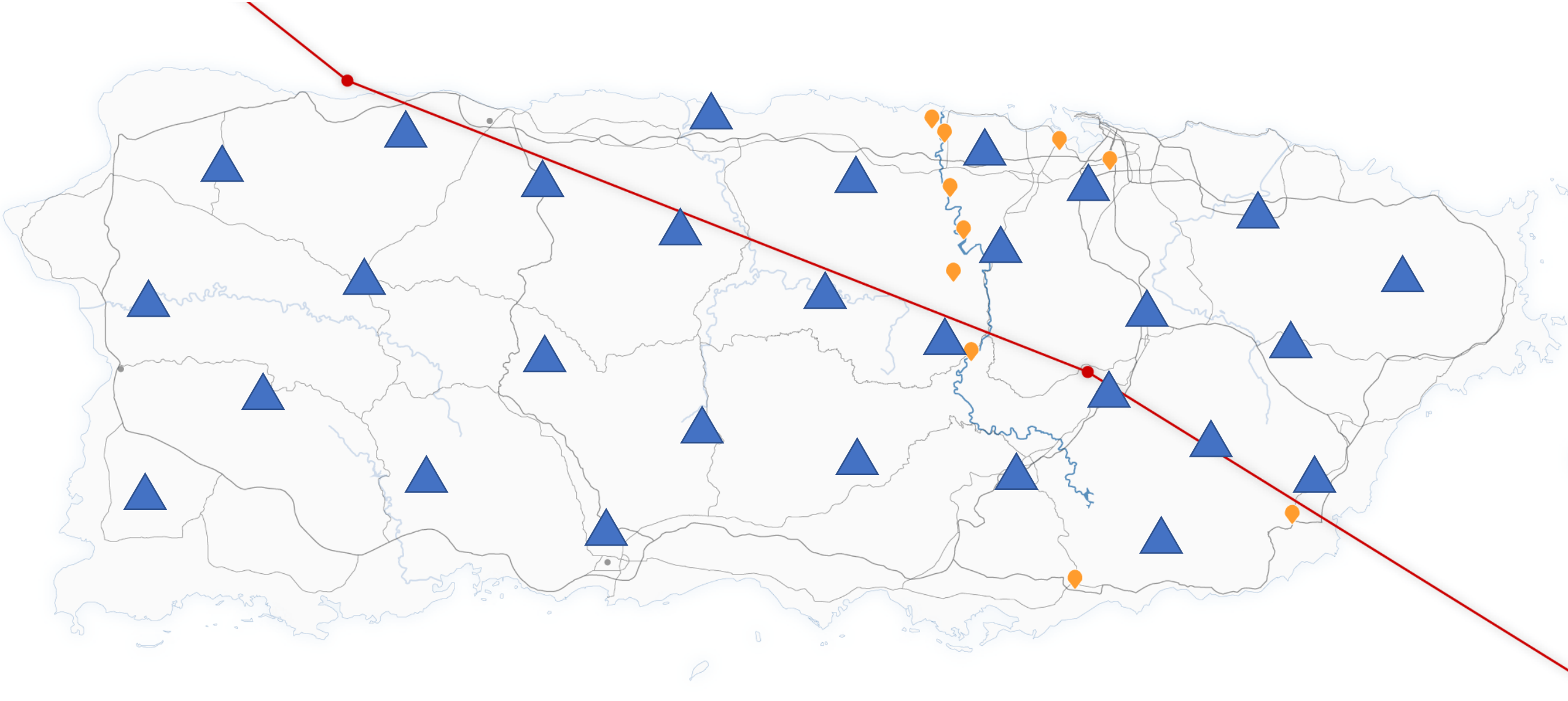
# What is peer-to-peer communication?

"Sharing messages or files between smartphones/computers connected directly to each other, without Internet access"

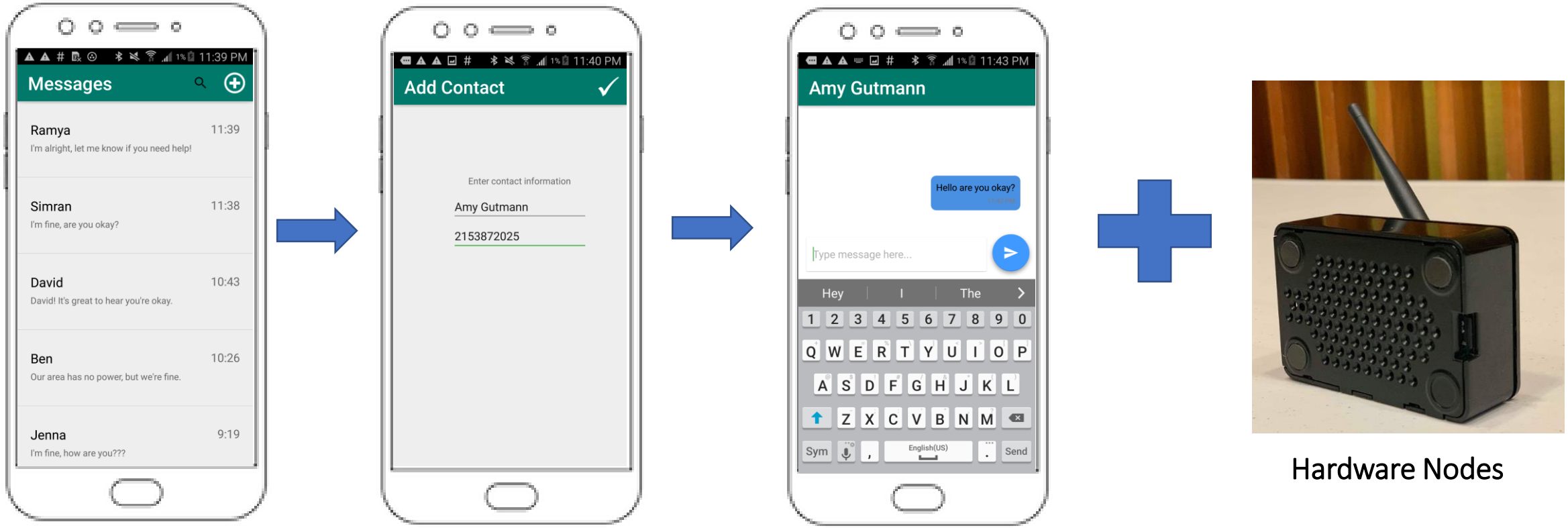


Peer-3-Peer: Connecting People

# Using Peer-3-Peer



# Peer-3-Peer Design



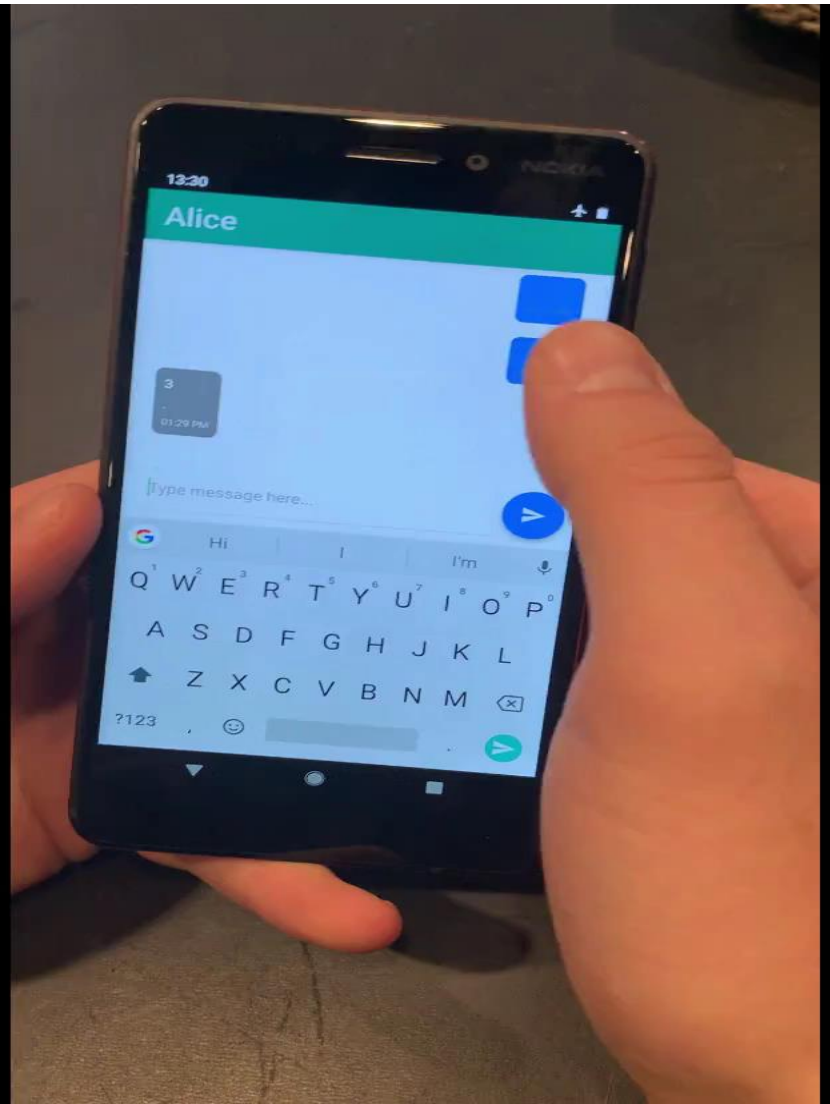

Mobile App

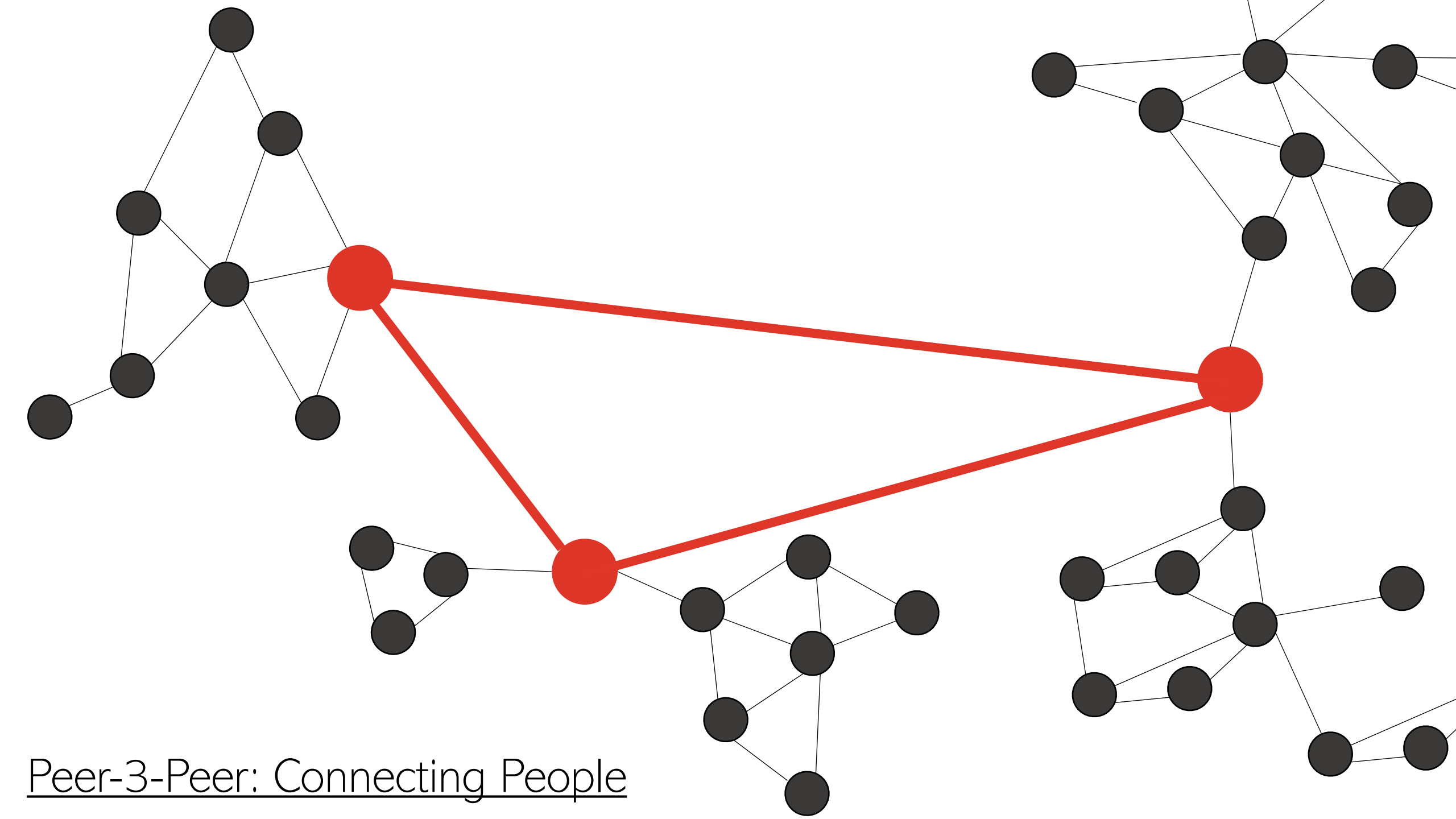
Hardware Nodes

# Demo: 2 phones communicate 500+ feet away.

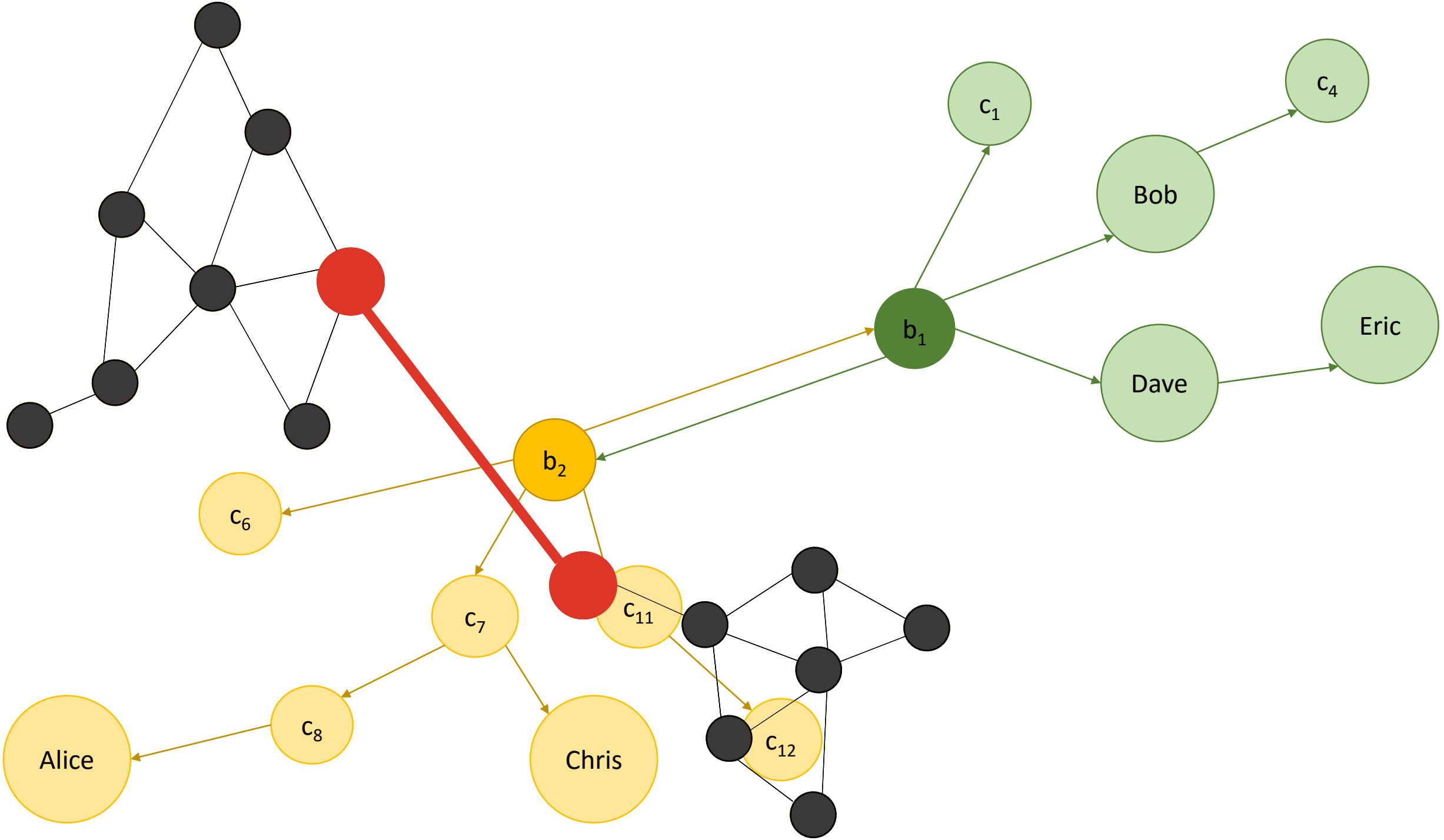
**Greenberg Lounge, 1st floor Levine**

**6th Floor Levine Bump Space**

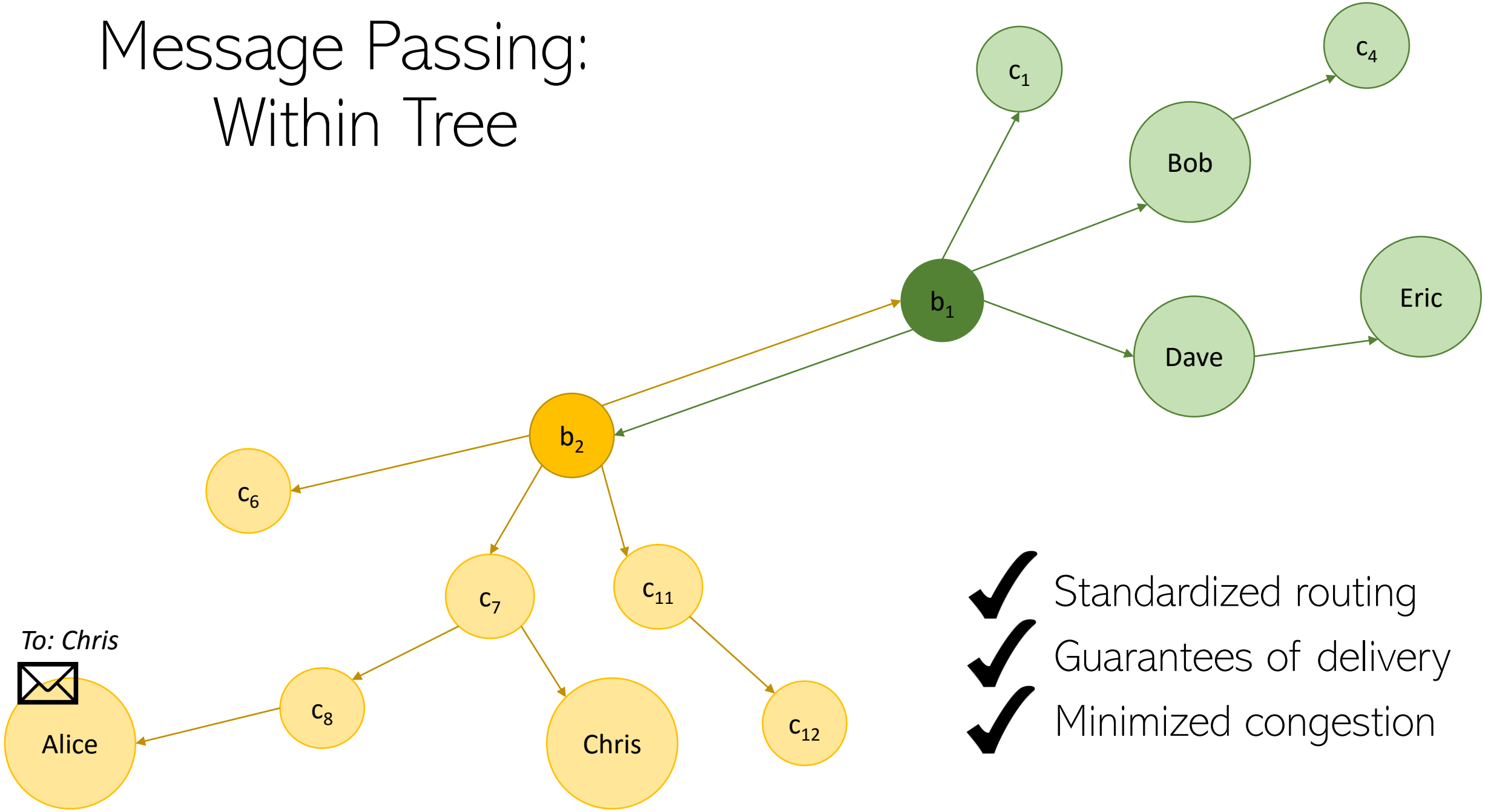




Peer-3-Peer: Connecting People

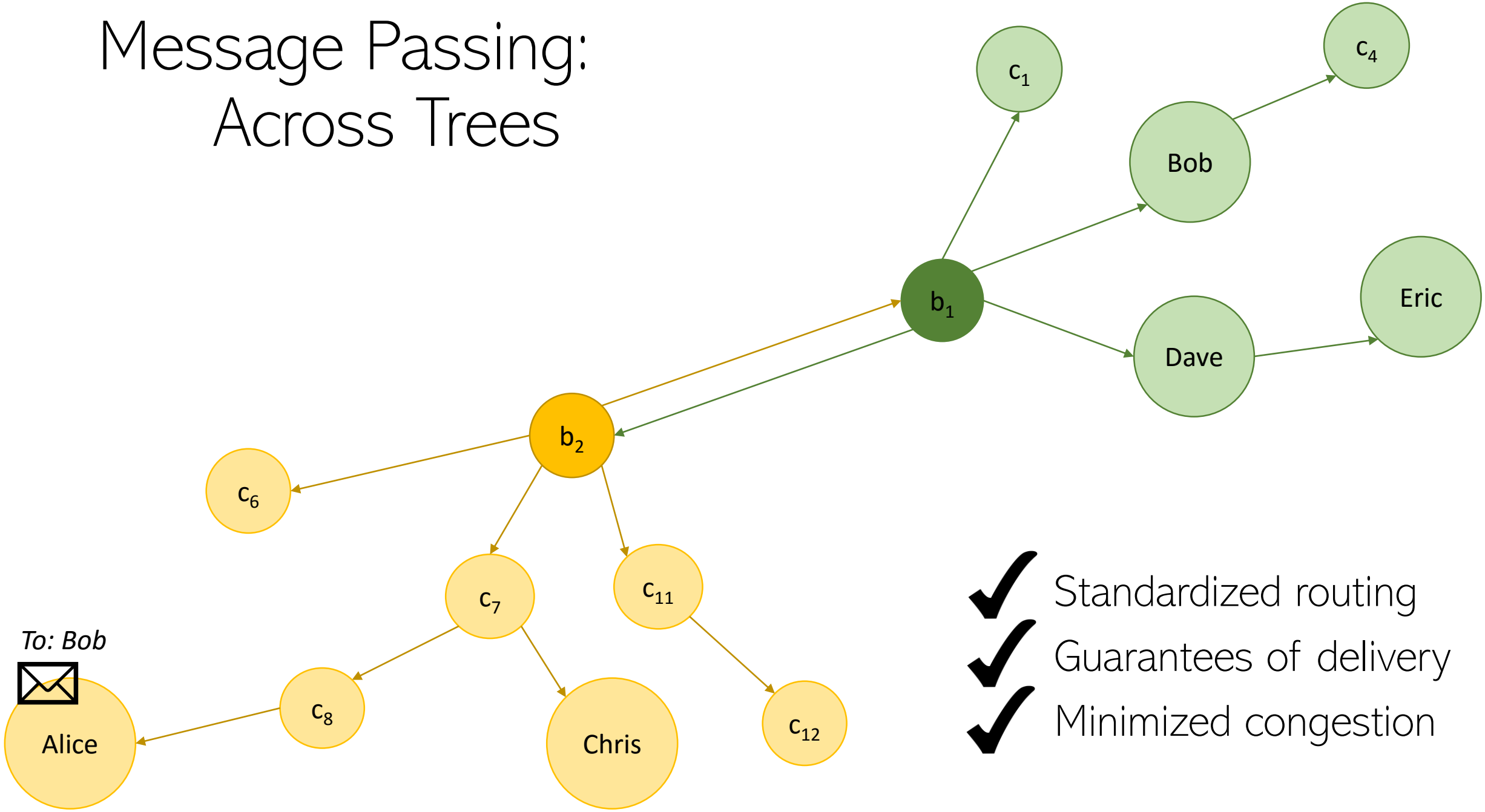

$c_1$
$c_4$
Bob
$b_1$
Eric
Dave
$b_2$
$c_6$
$c_7$
$c_{11}$
$c_8$
Alice
Chris
$c_{12}$

# Message Passing: Within Tree



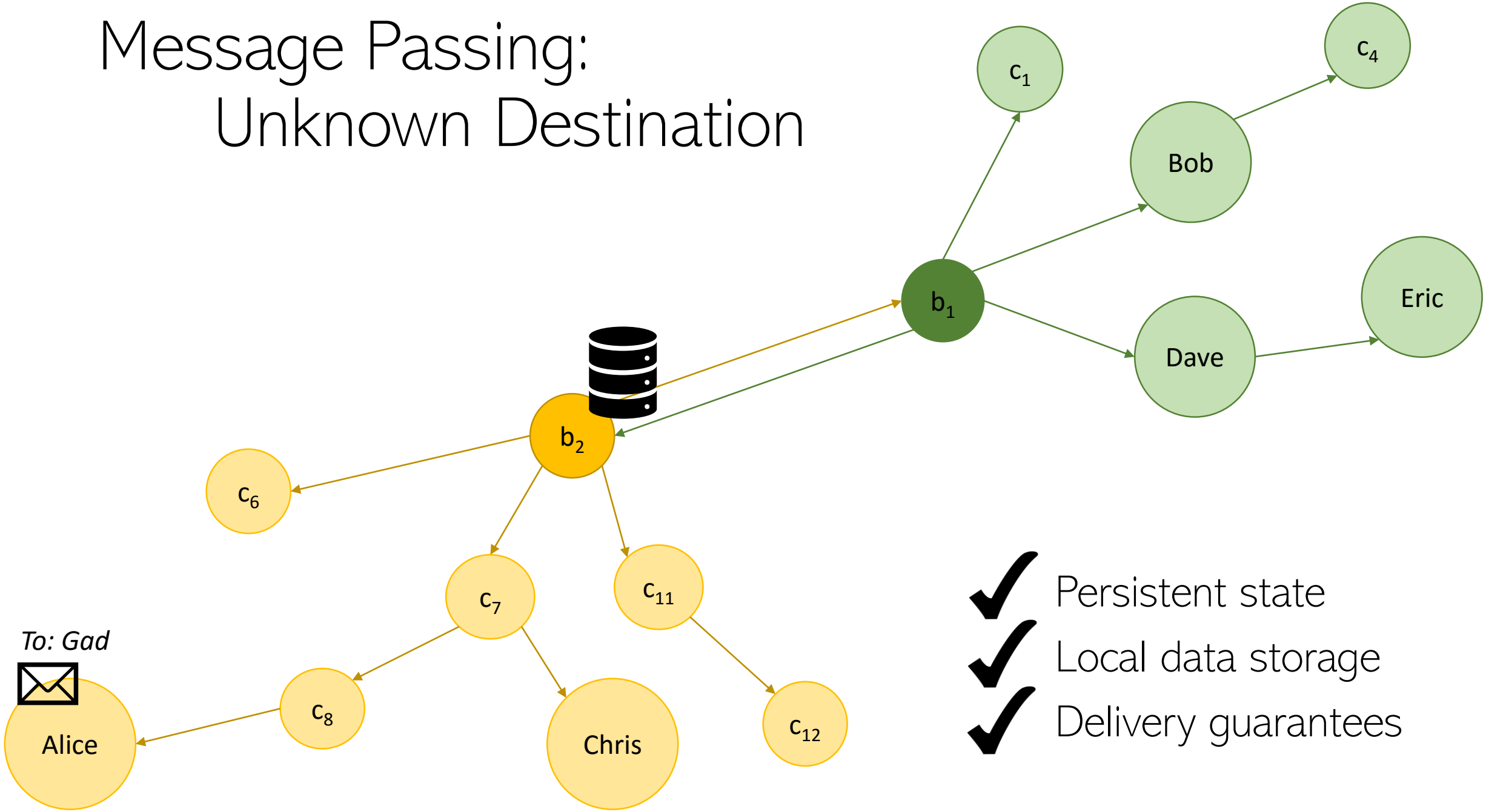

- ✓ Standardized routing
- ✓ Guarantees of delivery
- ✓ Minimized congestion

# Message Passing: Across Trees



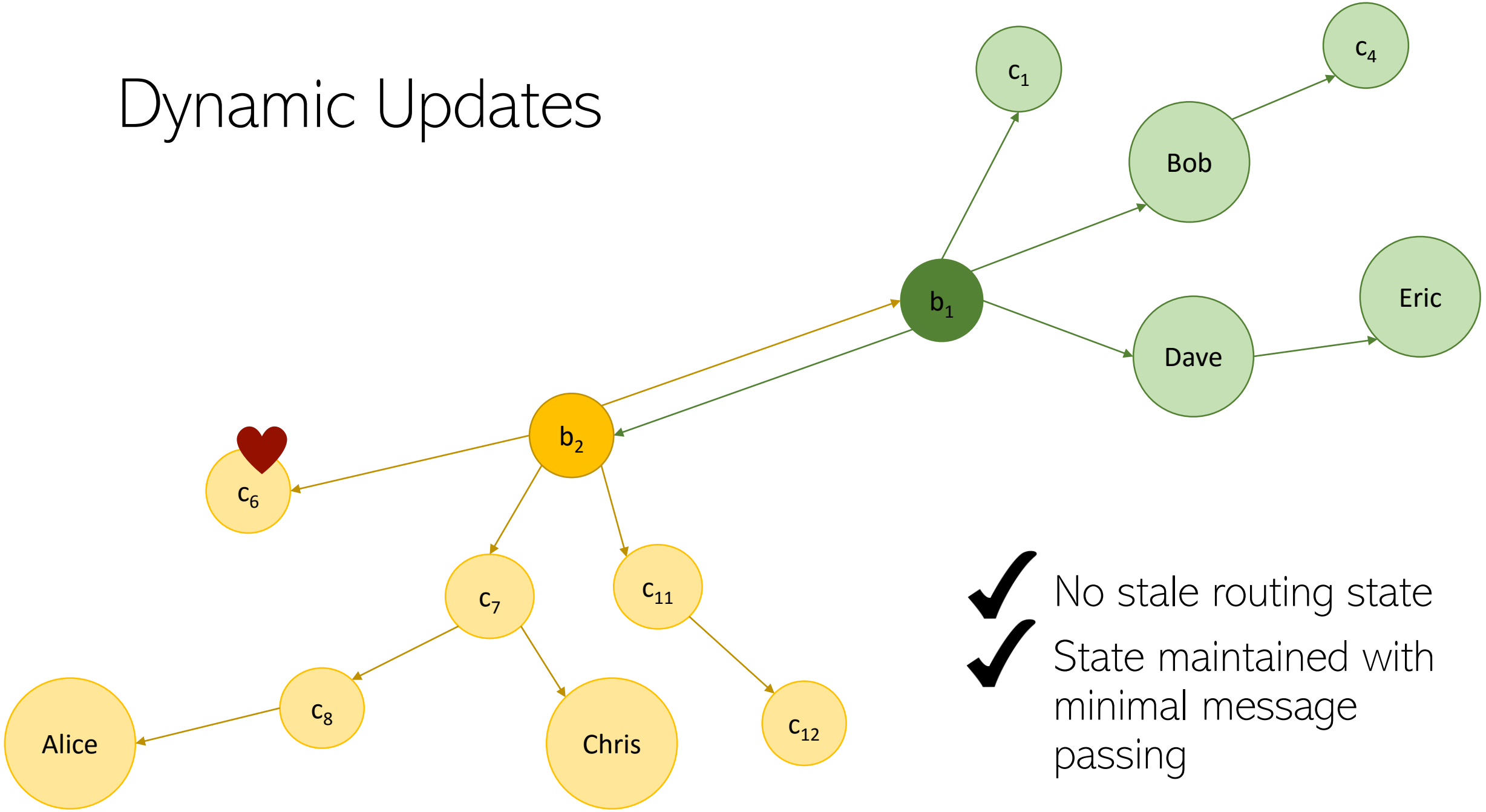

- ✓ Standardized routing
- ✓ Guarantees of delivery
- ✓ Minimized congestion

# Message Passing: Unknown Destination




- ✓ Persistent state
- ✓ Local data storage
- ✓ Delivery guarantees

# Dynamic Updates




- ✓ No stale routing state
- ✓ State maintained with minimal message passing

# Competitive Landscape

Coverage

Cell
Towers

Mobile
Cell-Towers

Walkie Talkie

**P3P**

FireChat

Peer-to-Peer

WiFi Mesh:
Serval Project

Internet
Transfer: Signal

Ease of Deployment

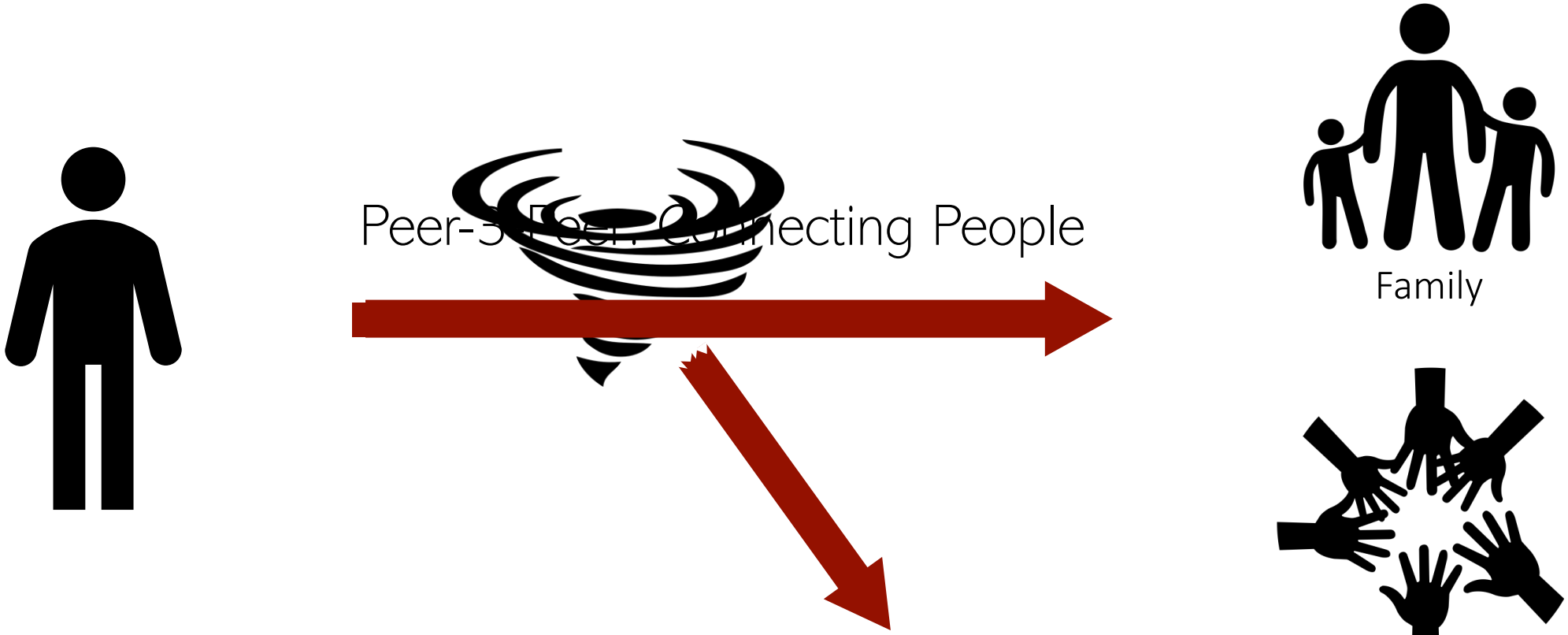
# Revenue Model

| | |
|---|---|
| WiFi Direct Range (mi) | 0.125 |
| Tree Depth | 3 |
| Backbone | 1 |
| Radius/Backbone mesh (mi.) | 0.5 |
| Area/Backbone (sq. mi.) | 0.8 |
| Disaster Region (sq. mi.) | 1872 |
| **Backbones/disaster** | **3743** |
| | |
| Cost/backbone | $33 |
| Profit Margin | 50% |
| Target price/backbone | $49.50 |
| Revenue/disaster | $185,295.00 |
| Disasters/year | 325 |
| **Revenue/year** | **$60,220,875.00** |

# Cost Model

- Packaging: Weatherproof Injection Molded ABS Casings
  - $20-30k Tooling Cost
  - $1/unit recurring costs
- CL-SOM-iMX7 NXP i.MX7 System-on-Module
  - $32/unit

# Peer-3-Peer can bring connectivity to those who need it.



# Thank You

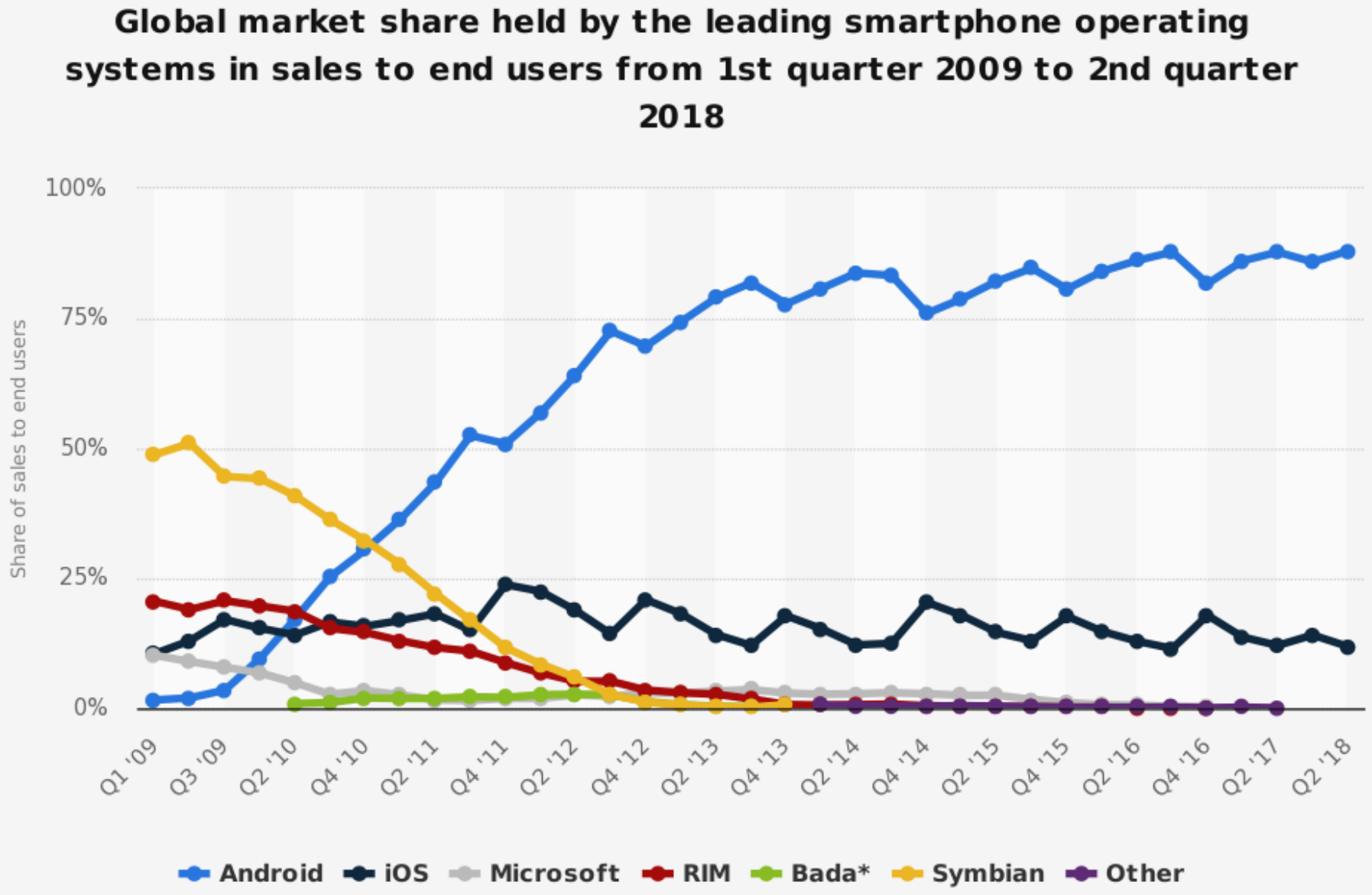
*We are grateful for the support of Professor Vincent Liu and Professor Ani Nenkova*

# Appendix

# Long Range Backbone Network



# Android Market Share




Source
Gartner
© Statista 2019

Additional Information:
Worldwide; Gartner; 2009 to 2018

# Accessories to Extend the Network

- Battery packs for remote deployment/drone deployment
- Rechargeable power supply
- Long range offline communication packs
  - XBee module
  - LoraWAN module
  - LiFi module

# Battery

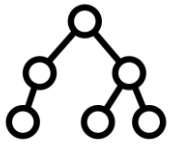
## Sources of Battery Consumption

Wi-Fi, LTE data rates, and GPS are top battery consumers

Processing video messages is one of the most power consuming operations on a mobile device

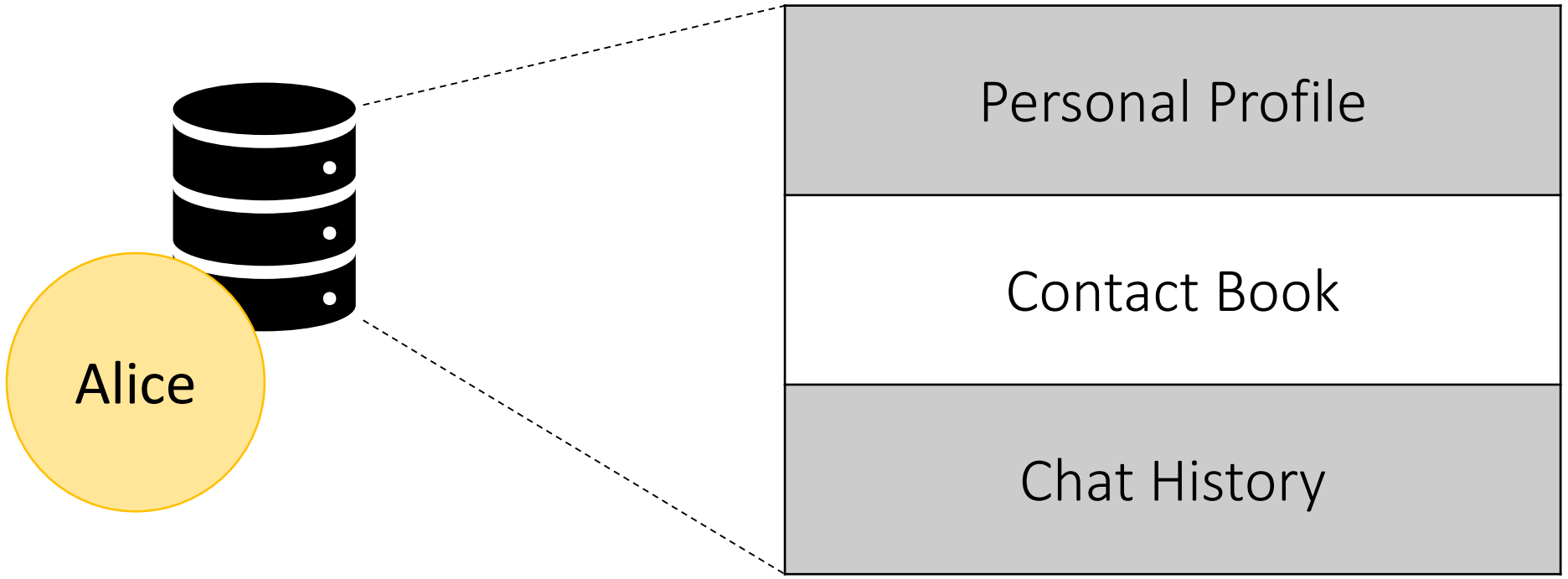
## Peer-3-Peer Opportunities

Aggressive duty cycling is possible due to our low latency needs

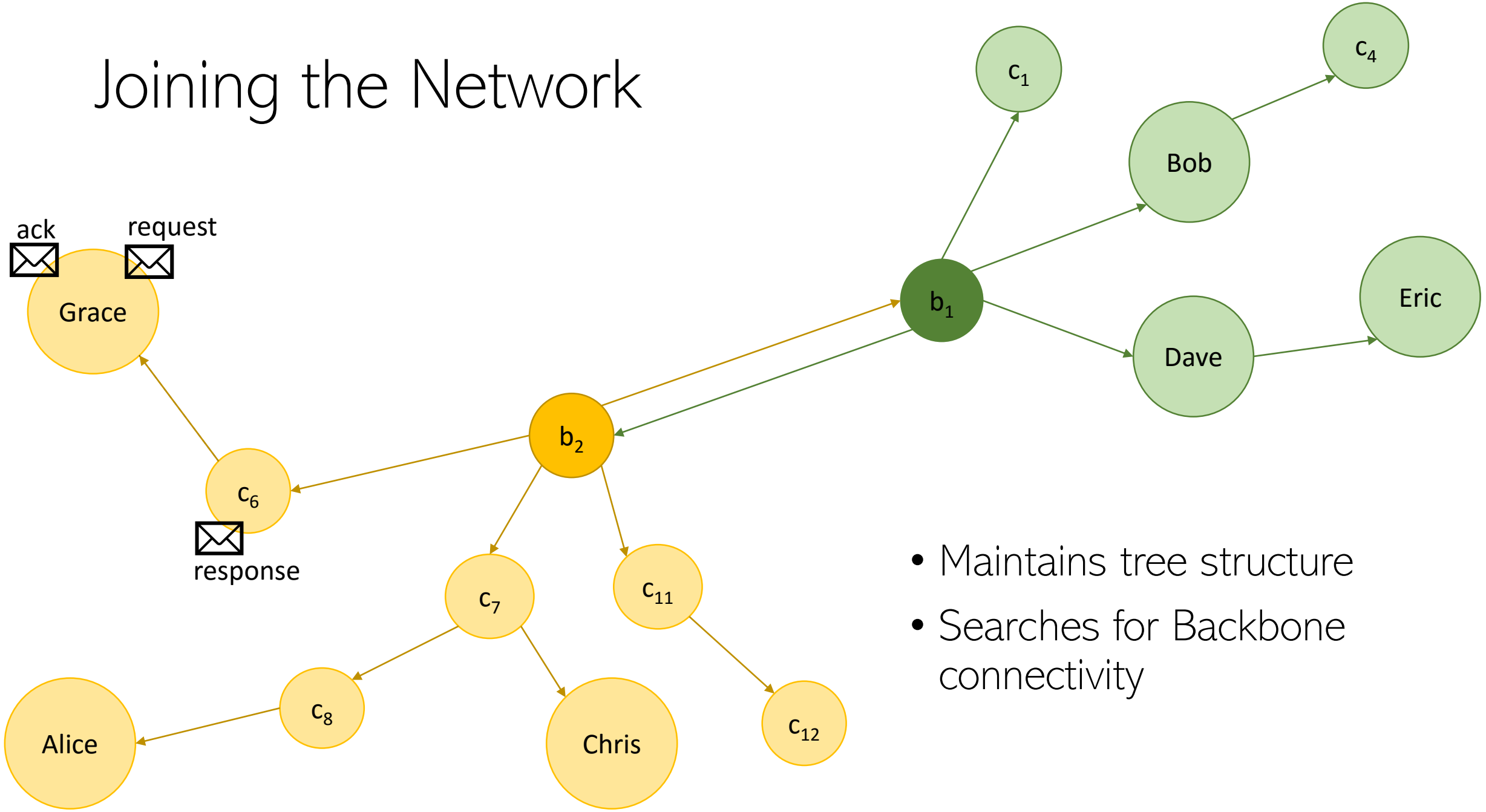


Tree overlay reduces message passing from $O(n^2)$ to $O(n)$

# Persistent Information

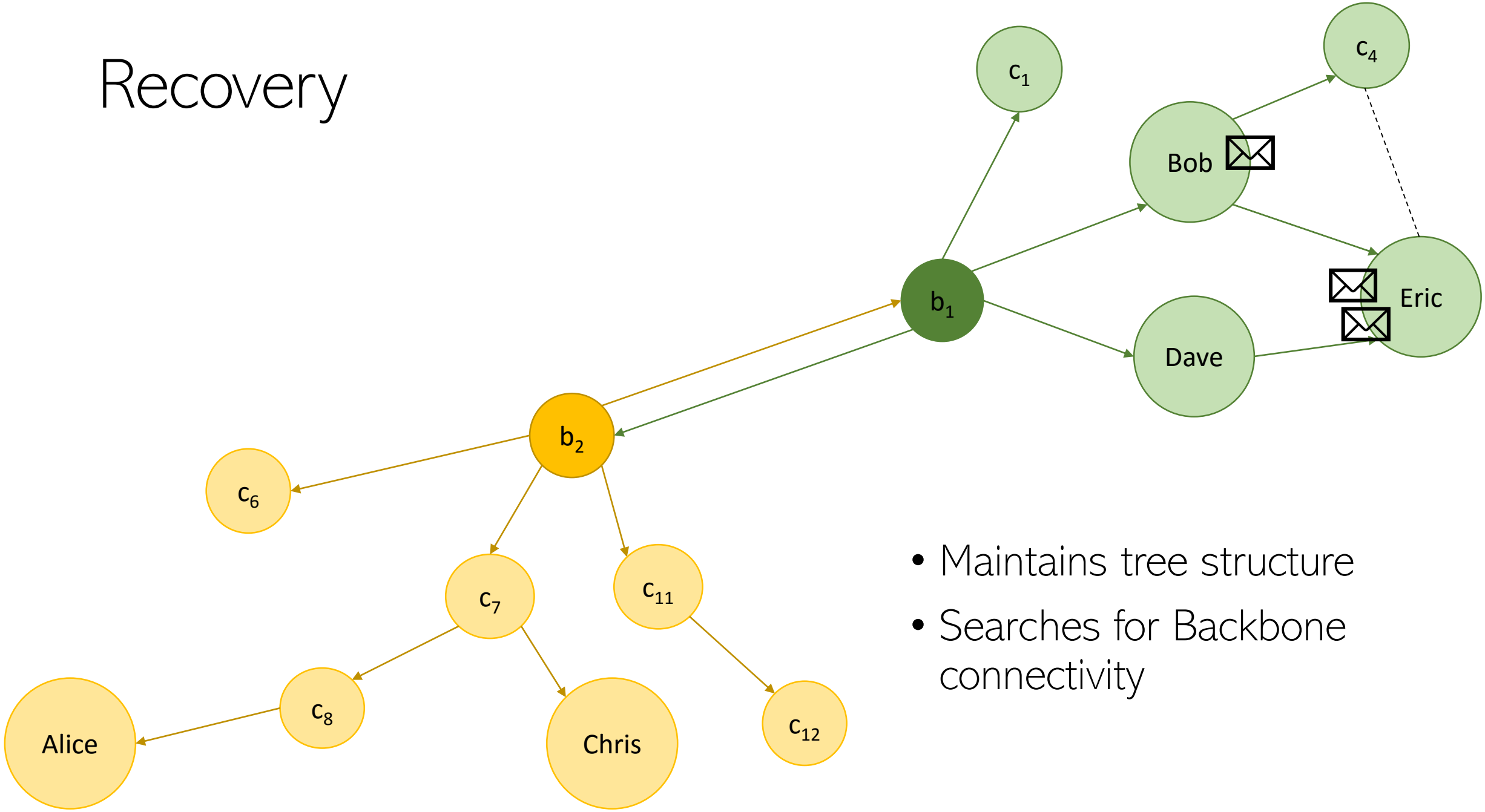


# Joining the Network




- Maintains tree structure
- Searches for Backbone connectivity

# Recovery

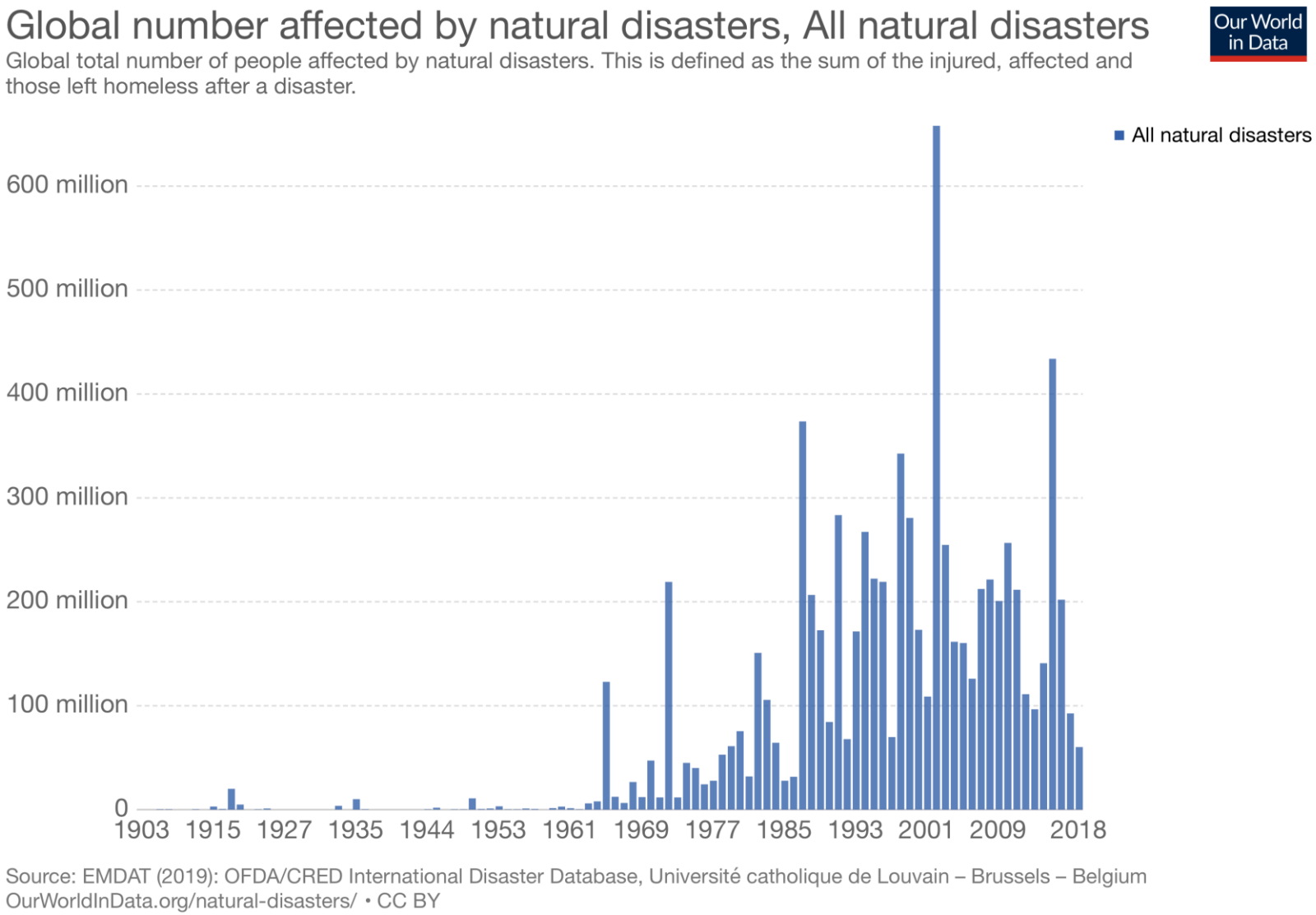



- Maintains tree structure
- Searches for Backbone connectivity

# Number of People Affected by Natural Disasters

Average number of people affected by disasters over the last 50 years:

153,752,155 people



# What They Deployed

Mobile Cell Sites

Flying COW

Google’s Project Loon