



MobilityFirst: Architectural insights and (some) NP research themes

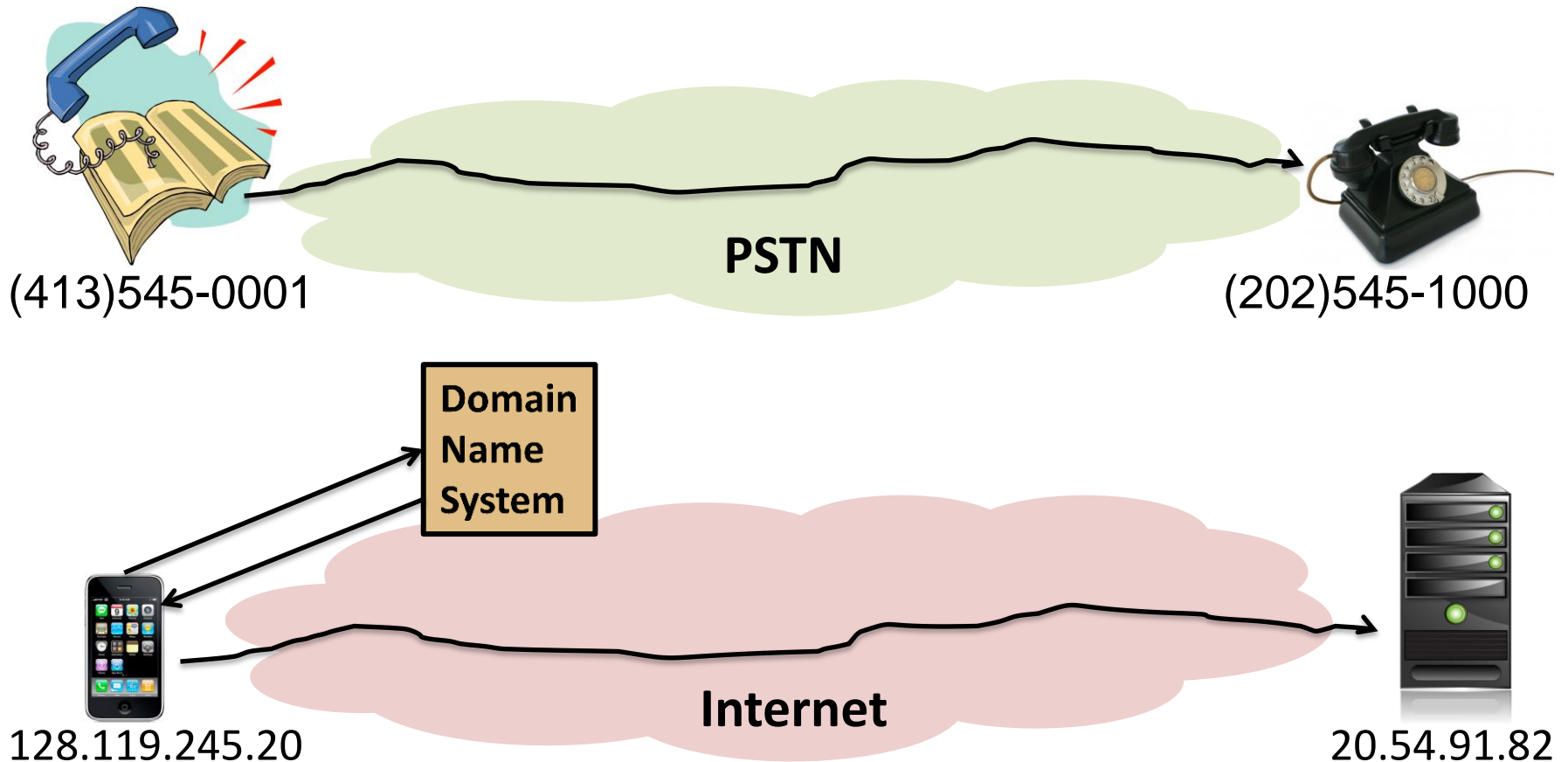
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University of Massachusetts Amherst

FIA PI meeting, Arlington, VA

May 2014

Internet is location-dependent



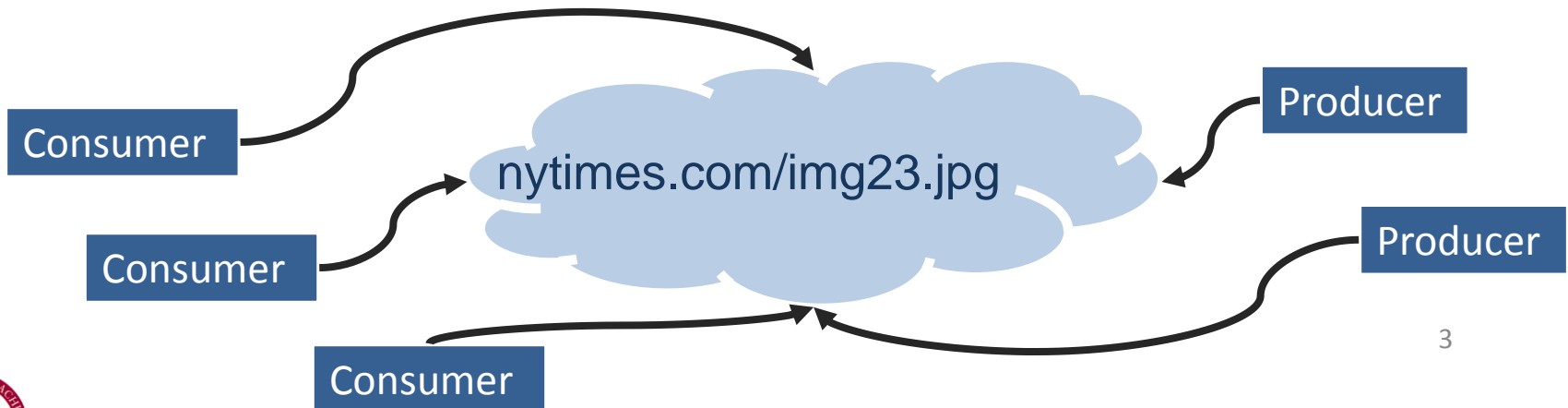
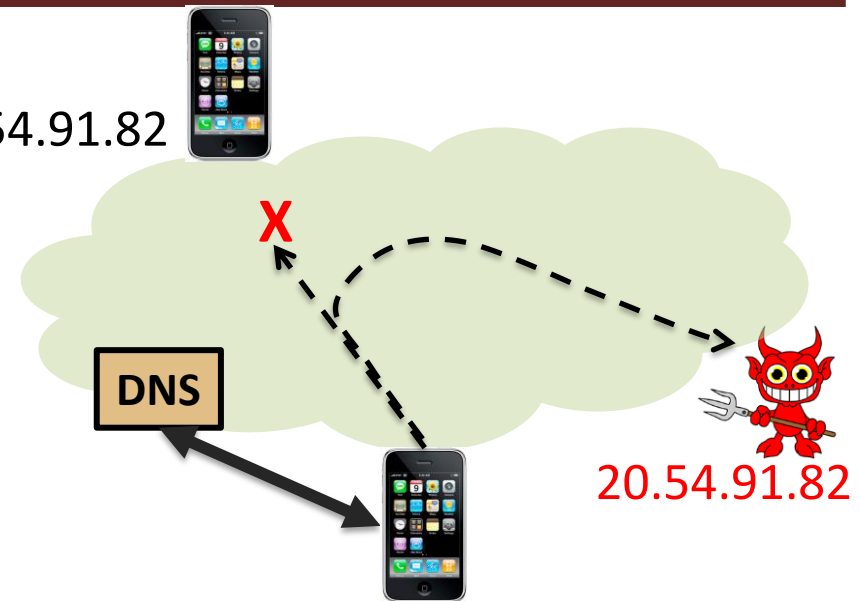
Location *is* the identity from the network's perspective

Location-identity conflation problem

- Mobility/multihoming 20.54.91.82

- Hijacking/spoofing

- Un-malleable principals



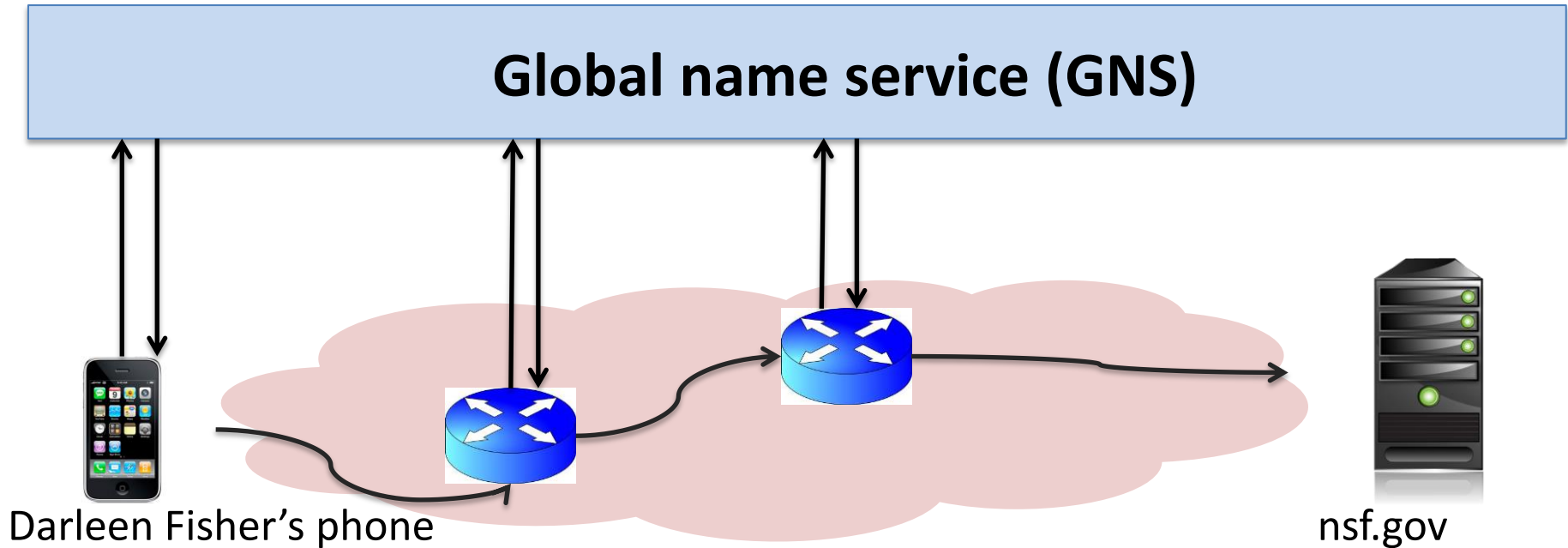
Goal: Secure Location-independence

- `connect(service_name)`
- `get(content_name)`
- `message(group_name)`

- Communication with fixed names
- Easily verifiable identities



Key architectural insight



A logically centralized global name service dramatically enhances mobility, security, and network-layer functionality

Benefits of GNS-centric approach

- **Mobility**
- Decentralized trust
- Context-aware
- Cloud-ready



GNS: Basic mobility

Global name service

HRN \rightarrow GUID

GUID \rightarrow NA

Name certification

Name resolution

certify(HRN)

HRN \rightarrow GUID

resolve(GUID)

HRN examples:

- www.nytimes.com
- edu/umass/cs/jimkurose/phone
- "David Stark's laptop"
- "ebay like service in china"

GUID:NA | data

NA₁

NA₂



GUID

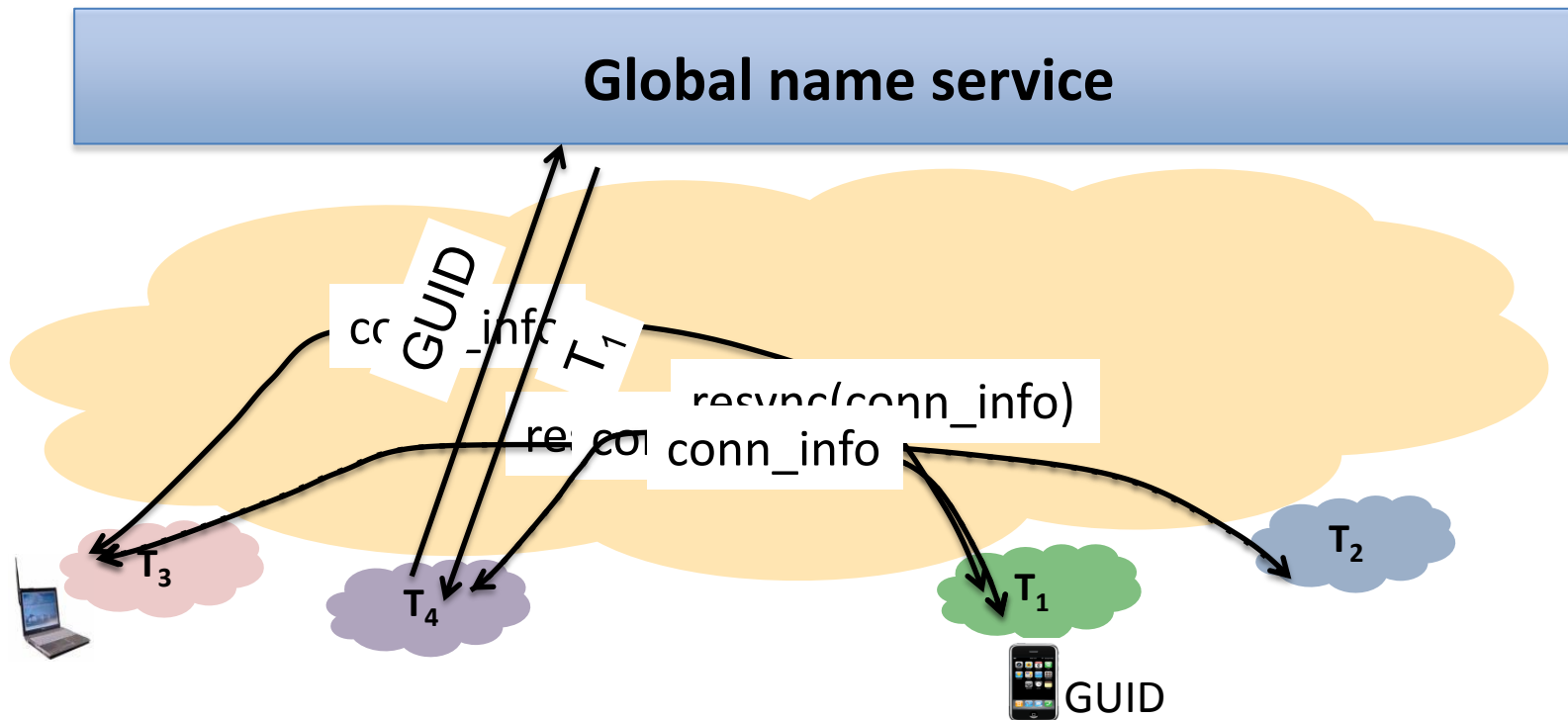


GNS: Complete E2E mobility solution



Mid-connection mobility

- Individual : Bilateral end-to-end (no GNS)
- Simultaneous: Relying on GNS



GNS: Complete E2E mobility solution

- A global name service offers the best combination of tradeoffs as a complete mobility solution [Auspice]
 - Constant update overhead per mobility event
 - Low connection establishment overhead
 - No additional data path inflation
 - Small (aggregateable) forwarding tables

[Auspice] A Global Name Service for a Highly Mobile Internet, ACM Sigcomm 2014

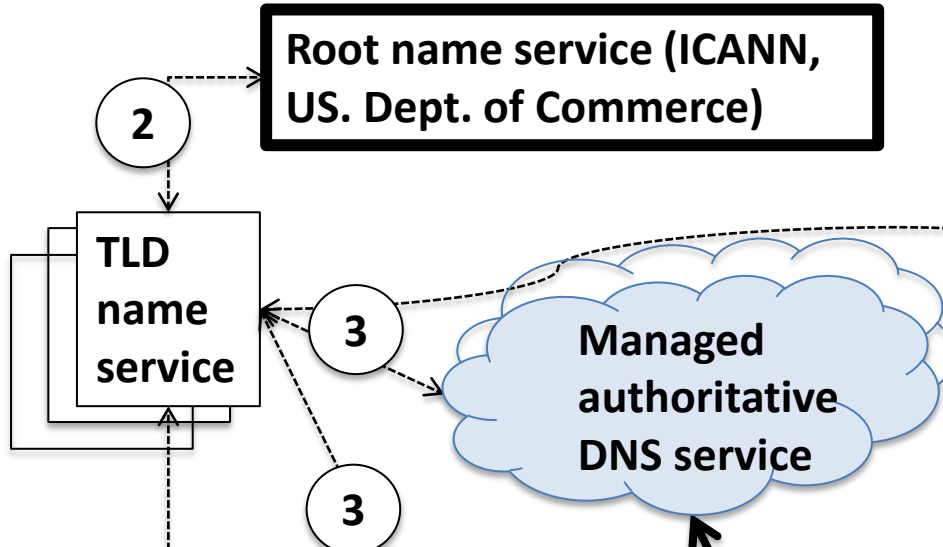


Benefits of GNS-centric approach

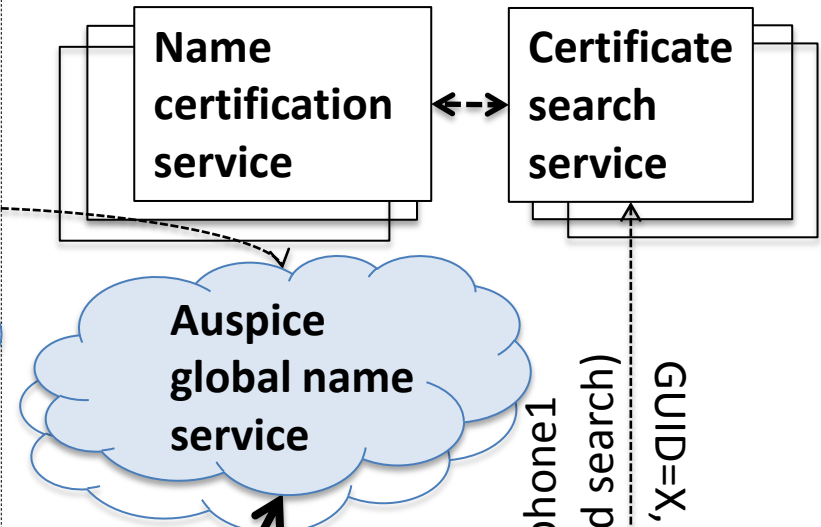
- **Mobility**
- **Decentralized trust**
- **Context-aware**
- **Cloud-ready**



Domain name system



Global name system



NP research issues

- Enabling byzantine fault-tolerant decentralized NCS
- Key management issues
- Inheritance of security privileges with grouping

Hierarchical names with federation tightly bound to name structure

Arbitrary human-readable names and flat GUIDs with federation by indirection via certification services

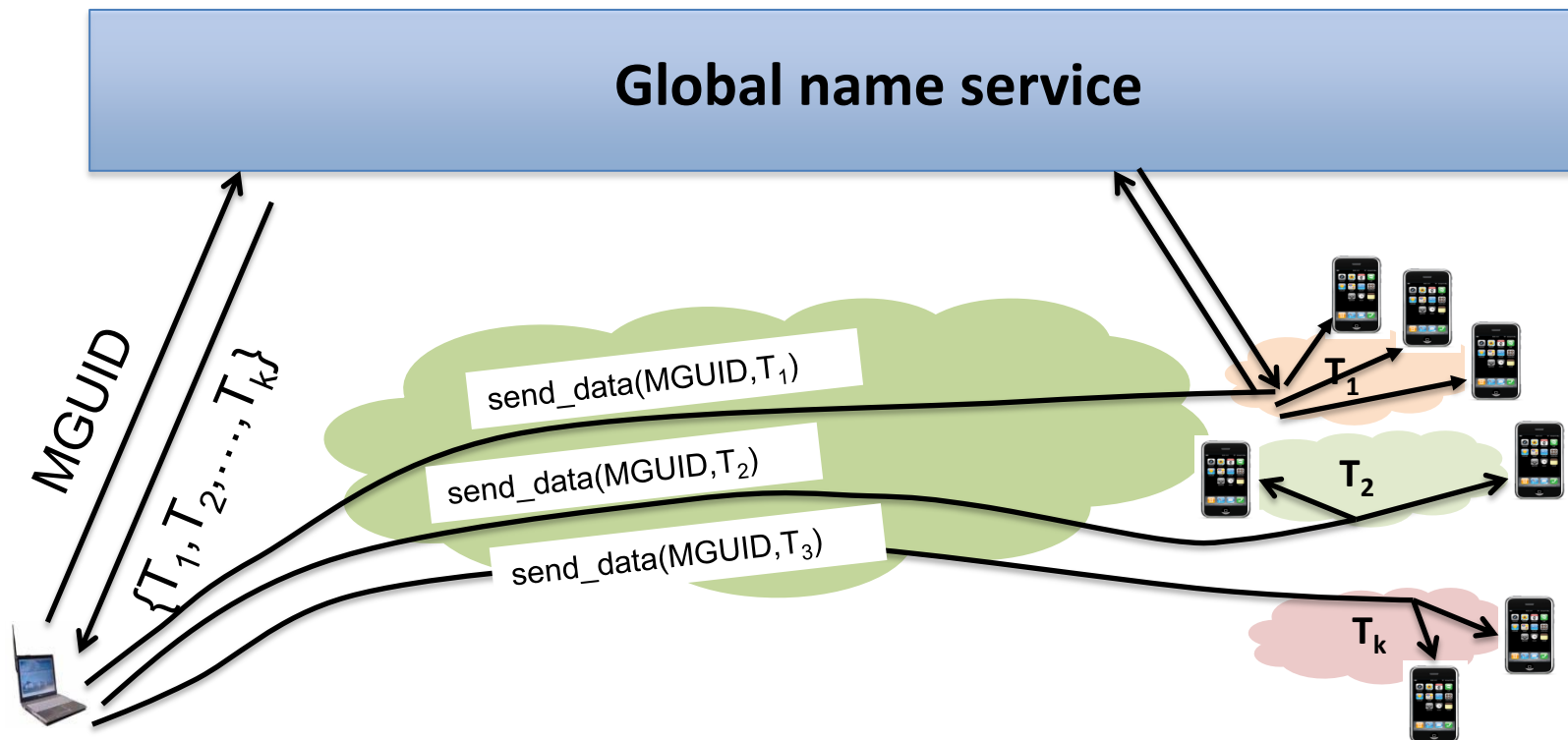
Benefits of GNS-centric approach

- **Mobility**
- **Decentralized trust**
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- **Cloud-ready**



Indirection + grouping: Multicast

- $\text{MGUID} \rightarrow \{T_1, T_2, \dots, T_k\}$ (terminal networks)
- $\text{MGUID} \rightarrow \{\text{members}(\text{MGUID}) \mid T_i\}$ (late binding)



Attribute-based groups: Context-awareness

- At source: $CAID \rightarrow \{T_1, T_2, \dots, T_k\}$ // get terminal networks
- At terminal n/w: $CAID \rightarrow \{\text{members}(CAID) \mid T_i\}$ // late binding

$GUID_i \rightarrow [T_i, \{\text{"type"} \rightarrow \text{"yellowcab"}, \text{"geo"} \rightarrow \text{"Times Sq."}\}]$

$GUID_i \rightarrow CAID$

Global name service

$CAID \rightarrow \text{members}(CAID) \rightarrow \{T_1, T_2, \dots, T_k\}$

NP research and field trial issues

- Scaling context-aware communication to fine-grained groups
- Refining programming API
- Demonstrating *targeted geocast* under hazardous weather (CASA radar testbed in Dallas-Fortworth)



Massively distributed cloud services

NP research questions:

- Expanding base station services with massive distribution
- Automating placement of blackbox services
- Tighter integration with network fabric
- Incentive and deployment issues related to Compute Layer



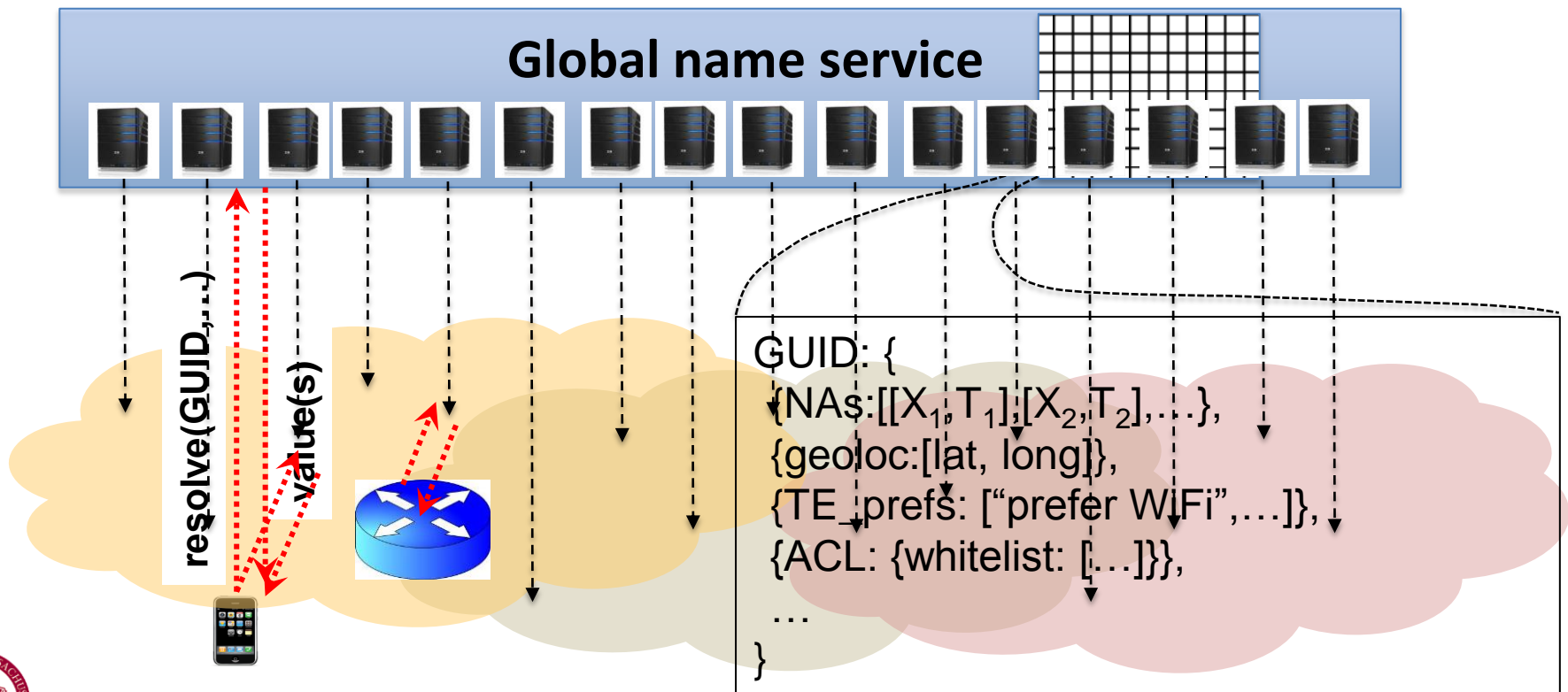
GNS enables geo-elastic services that “move with the users”

PROTOTYPING



GNS: Massively geo-distributed key-value store

- Indirection: $\text{GUID}_1 \rightarrow \text{GUID}_2$
- Grouping: $\text{GUID} \leftrightarrow \{\text{GUID}_1, \text{GUID}_2, \dots, \text{GUID}_k\}$
- Attribute lookups: SELECT GUID with *attr=value*
- Active names with programmable user code

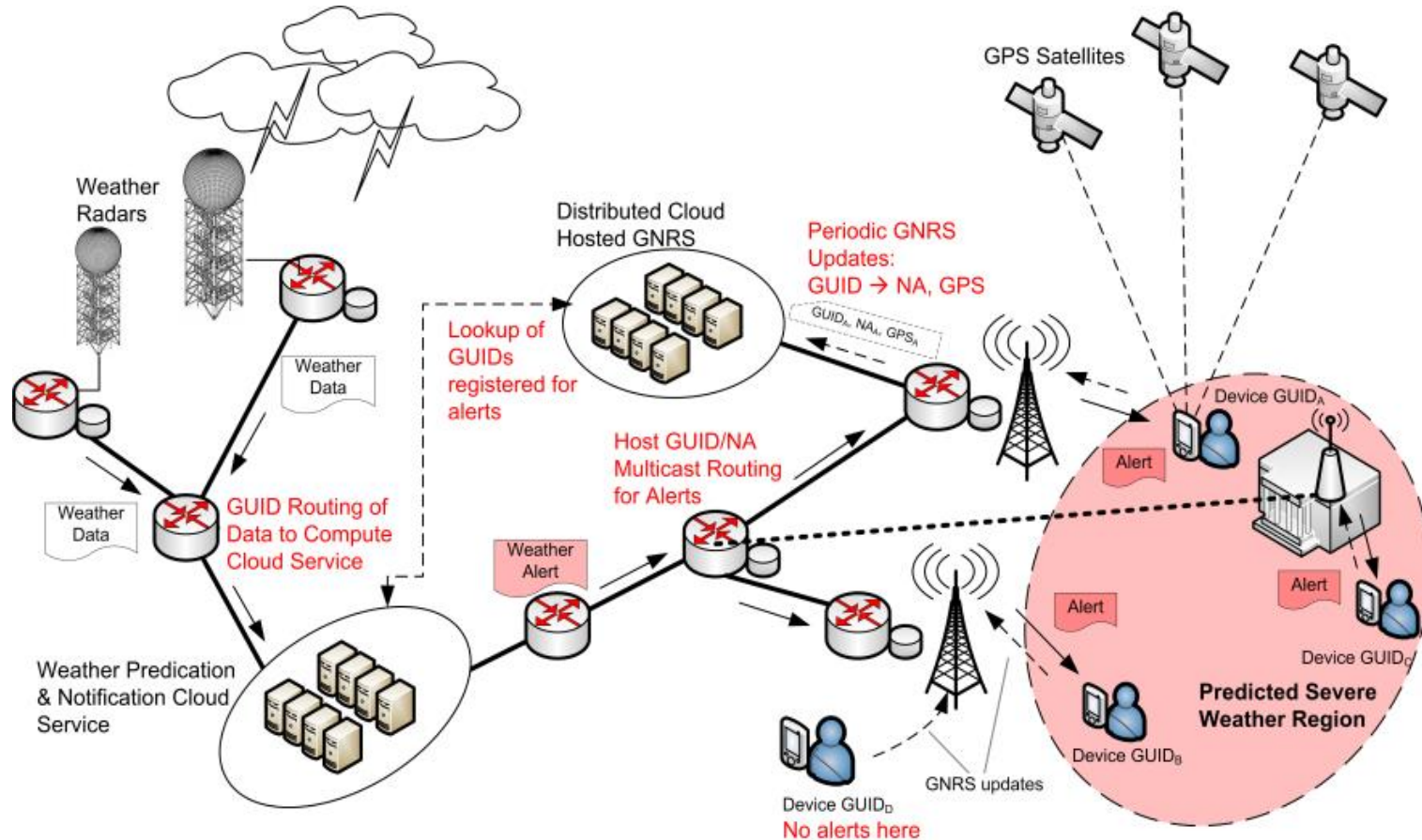


msocket: GNS endpoint socket API

- **Mobility:** all four types
- **Multihomed multipath:** cellular/WiFi multiplexing
- **Middlebox-agnostic:** bidirectional comm. initiation
- **Context-awareness:** `msocket.bind([lat,long], radius)`



NE Trials: CASA Emergency Network



NE3: Context-Aware Emergency Notification System (CASA)



Summary

- Key architectural insight: A logically centralized global name service dramatically enhances mobility, security, and network-layer functionality
 - Location-independence
 - Decentralized trust
 - Context-aware communication
 - Smart geo-elastic cloud services
 - Evolvability (active resolution, compute layer)
 - Byzantine fault-tolerance, DDoS tolerance
 - Simplified management
 - Content-awareness

<http://mobilityfirst.cs.umass.edu>



Backup

