

# NUMBERING WORKSHOP

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FCC

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# Overview

- Meta-assumptions
- Architecture
- Data
- Operations
- Testbed structure & logistics

# Meta-assumptions

- ~~“We’ve always done it this way”~~
- Old:  $\text{policy}(t_1) \rightarrow \text{implementation}(t_1+T)$
- New:  $\text{technology platform}(t) \rightarrow \text{policy}(t_1), \text{policy}(t_2), \text{policy}(t_3)$
- discussion:  $\text{technology} \text{ ☺ } \text{policy} \text{ ☠}$
- All +1 numbers, including 800#
  - but avoid being too +1 specific
- Possibly others: SMS short codes, CICs
- Scalable, reliable, trustworthy, neutral, ...
- Where can multiple (protocol, data, architecture) solutions avoid philosophical arguments and speed progress?
- **Presentation meant to foster discussion and gather possibilities, not preclude alternatives or prejudge outcomes**

# Non-goals

- Short-term changes to numbering administration
- Change numbering policies, contracts, ...
- Agree on solution

# Reconsider assumptions?

- NANPA, LNP, LERG, RespOrg, ... separation?
  - NANP Administration System (NAS)
  - Pooling Administration System (PAS)
  - Number Portability Administration Center (NPAC)
  - → *Number Administration Database?*
- numerous separate databases with often unclear data flows and opaque business models (e.g., CNAM)
- “Golden root” databases → can the technology support a federated, competitive model similar to the white space databases?
  - roughly 10 operators that exchange data to ensure consistency

## Sample policy variables (beyond workshop scope)

- Who can get what kind of +1 numbers?
  - carriers and other telecommunication providers
  - organizational end users
  - individuals
- In what units?
  - 1, 100, 1000?
- Are numbers restricted (in use or portability)?
  - by geography (NPA? LATA? rate center?)
  - by service (mobile, SMS, “freephone”)?
- Who pays for what?
- What attributes are associated with a number?
  - Who can read & write those attributes?

# Who are the actors?

- Service providers: carriers, hosted providers (“cloud”), self-provisioned large enterprises, RespOrgs, ...
  - some obtain numbers for their customers
  - some just route to them
- Number management entities
  - registrars, registries
- Third-party verifiers [TPV] (e.g., for porting)
- Property validators (for numbering meta data)
  - Experian, Dun & Bradstreet, Neustar, government agencies, ...
- Consumers
- Regulators
- Others?

# Additional numbering uses?

- Validated or asserted attributes
  - “extended validation”
  - e.g., geographic location, registered name, licenses
- Numbering administrators as identity providers
  - phone number as login credential
  - possibly with return path validation?

# Goal: stop (or reduce) illegal robocalls

- Consumer fraud
- Nuisance
  - impact on landline higher than cell phone → increase abandonment of landlines?
- Loss of phone numbers (personal & small business)
- Impact on legitimate mass-calling services (e.g., alerts)
- Cost to carriers:
  - Customer service calls with no good resolution
  - ICC fraud

# Stop spoofing → stop robocalls

- If numbers can be trusted, filters work:
  - industry-wide fraudulent number list (e.g., DoNotCall violators)
  - crowd-sourcing “bad” numbers by other consumers and services
- Filter options:
  - opt-in service by terminating carrier (e.g., using consumer-chosen source of numbers)
  - app on Android smartphones
  - corporate PBX and hosted VoIP services
- Enable consumer choice
- Note: initially, only some calls will be validated

Type of call	Validated?	Sample action
Personal friend (in address book)	Maybe	answer
“Good” robocaller (e.g., alert service, airline)	Yes	answer
“Lazy” robocaller (legal)	No	voicemail
“Bad” robocaller	No	voicemail

# Three parts of phone number identity

## Phone number (CNG)

- nuisance call backs
- vishing

## Textual caller ID

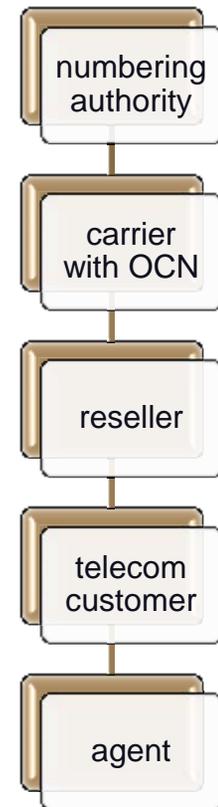
- impersonation (“IRS”)
- Citibank & Citybank

## Properties

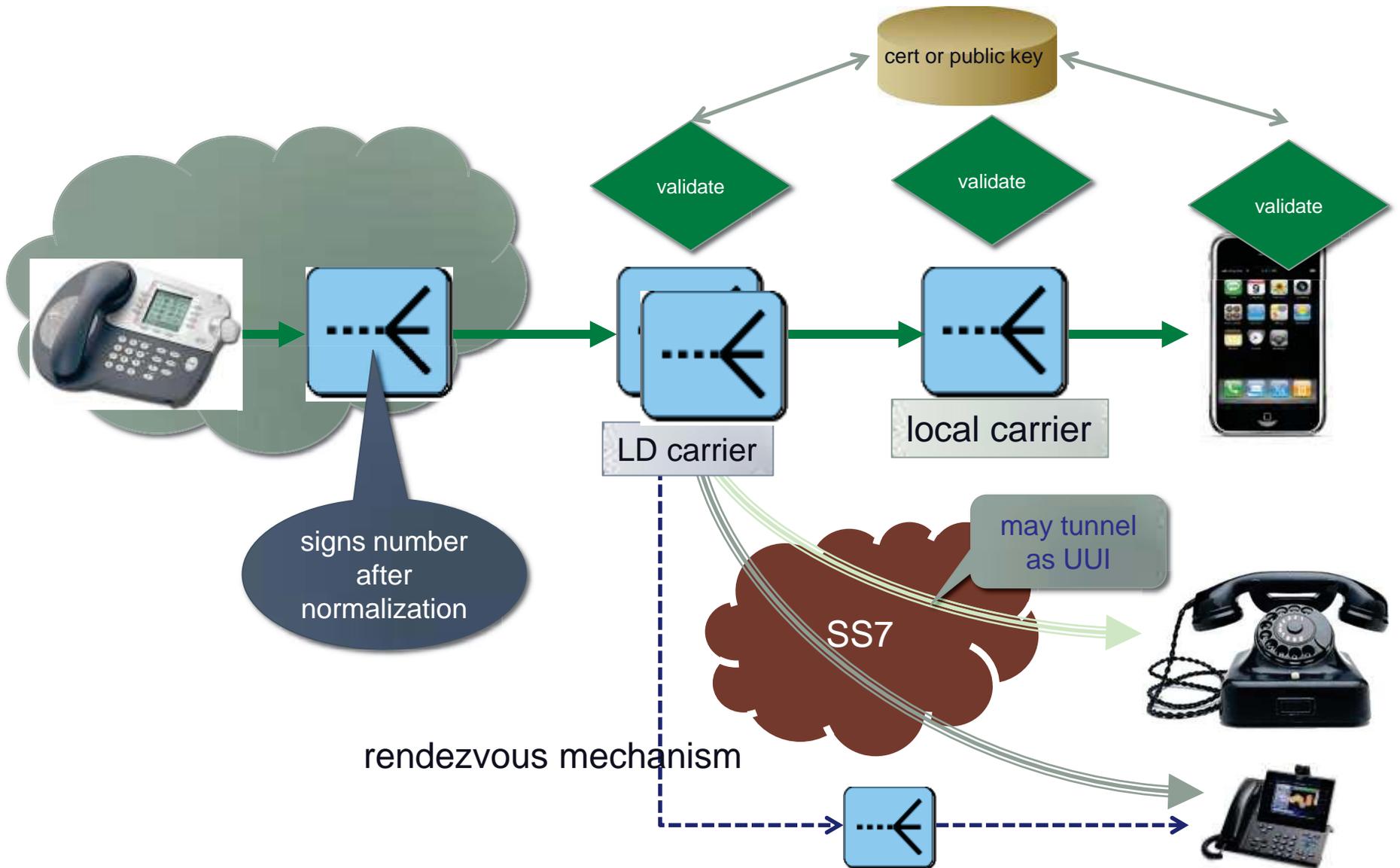
- registered charity
- political candidate
- gov’t agency
- bank

# Caller validation requirements

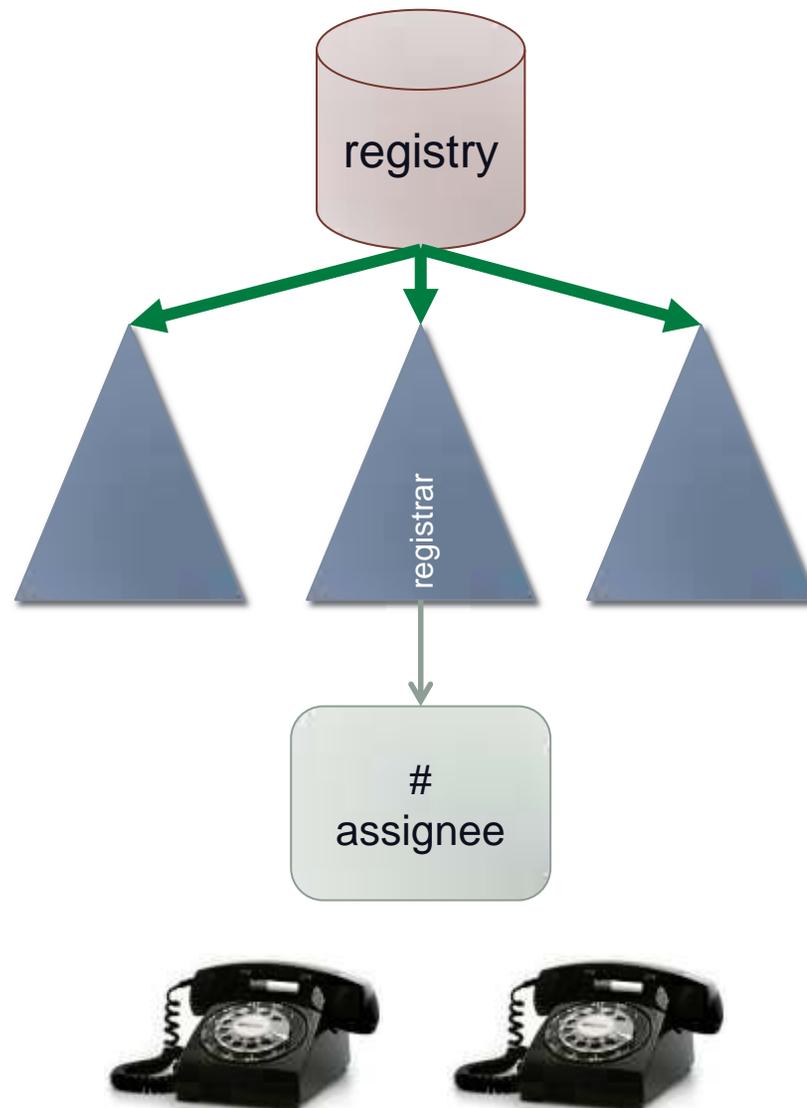
- Multiple legitimate users of number → multiple private-public key pairs
  - Carrier, (large) customer, agent of customer (call center)
  - Avoid interruptions if (say) agent changes
- Incremental deployment with at least proportional value
  - protect high-value targets first
- Work with existing number management systems
  - may have separate interfaces
  - but not too strongly tied – may evolve slowly
- Avoid single high-value key store targets
  - don't want to revoke all +1 numbers
- Avoid religious arguments about DNS vs. HTTP



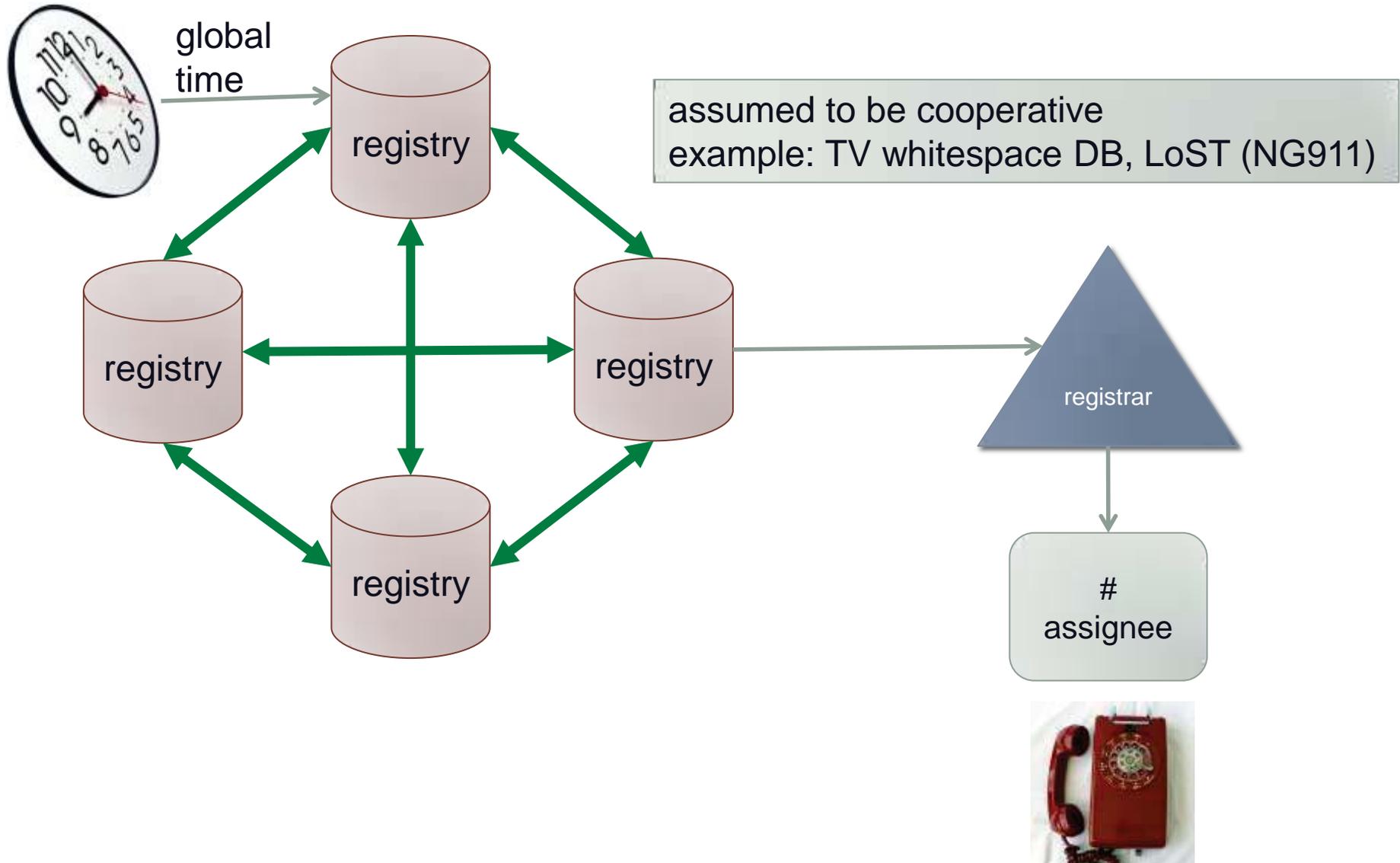
# Basic caller-ID validation architecture



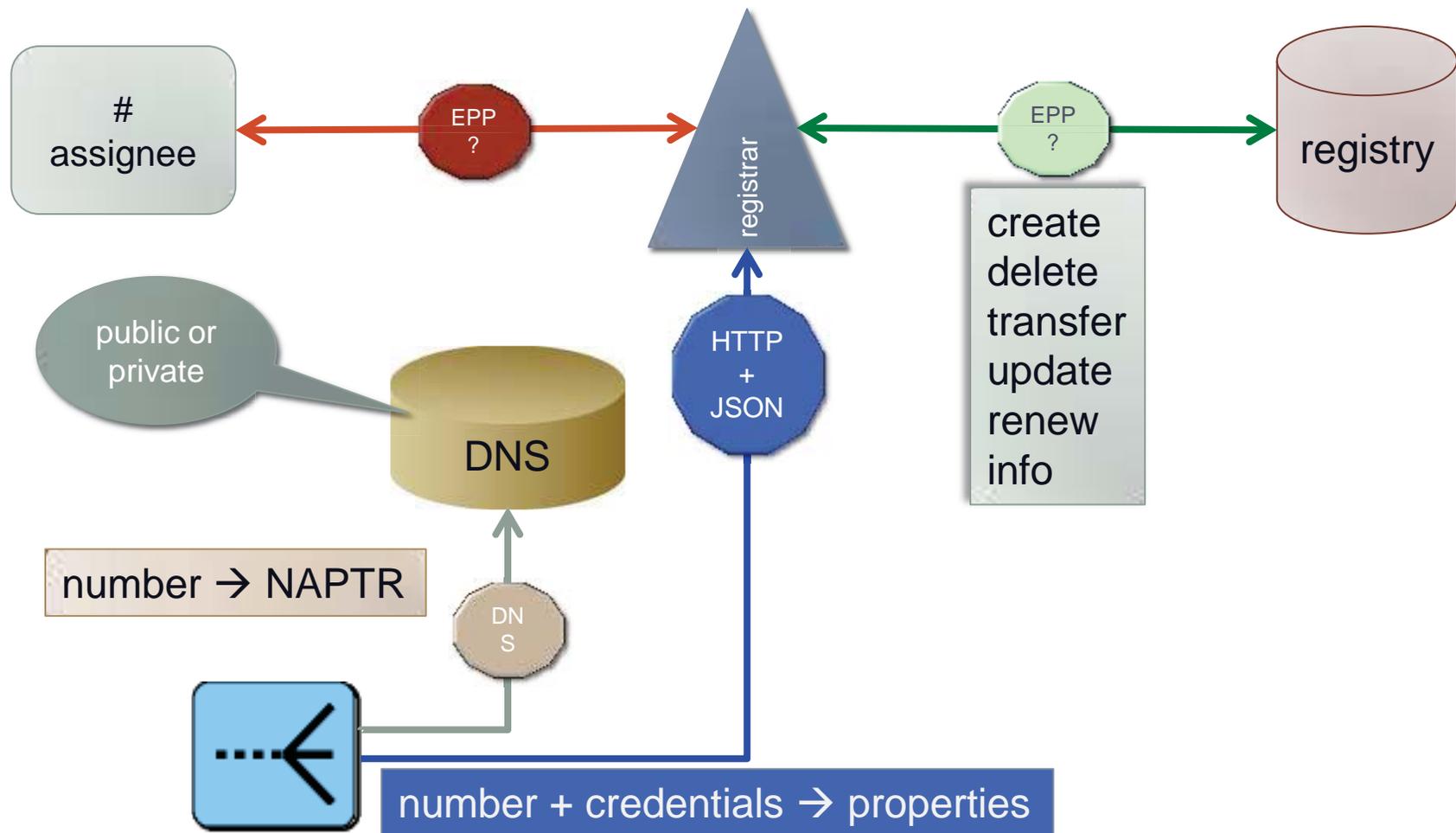
# Architecture 1: tree



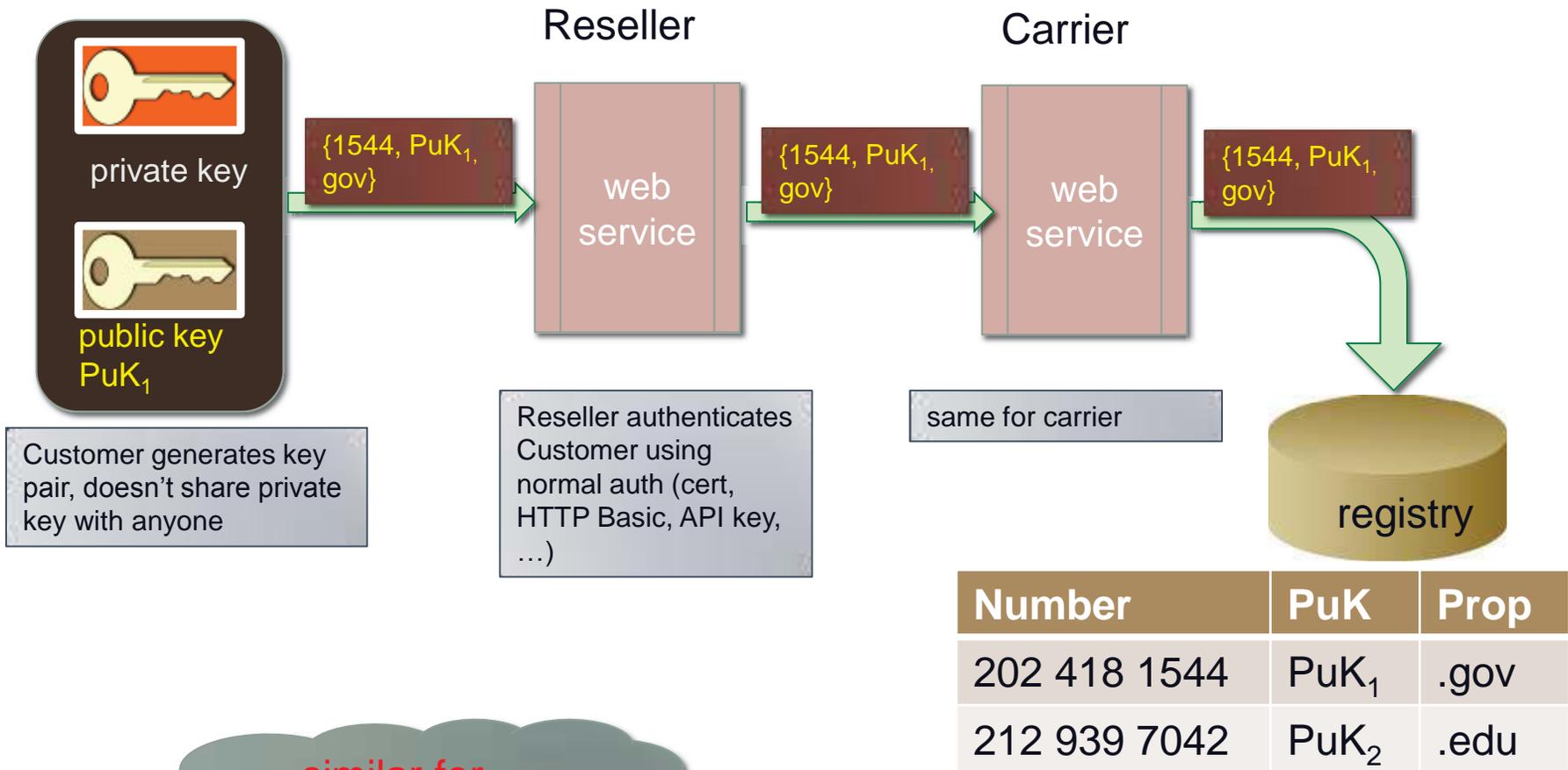
# Architecture 2: mesh + tree



# Protocol interactions



# Validation: assignment with delegation



similar for certificate → CSR

# Record granularity

- (1) Single record for each number
- (2) Split records by
  - geography → separate carrier by NPA or geographic region?
    - allow geographic splitting of 800#
  - service → separate carriers for audio, video, text, ...
- (3) Others?

# Number meta-data

Data element	Comments
E.164 number	key
OCN	several for different media & geographic scope?
Expiration date	if records expire
Public key	for STIR
whois record	similar to domain name?
Log entries (who, what, when)	need to be visible?
?	

# Whois record

- Domain names
  - creation, expiration dates
- Registrant (assignee) information
- Contacts: tech, billing, admin
- Name server information → NS record
- Currently, retrieved by simple TCP request → WEIRDS
  - RESTful + XML

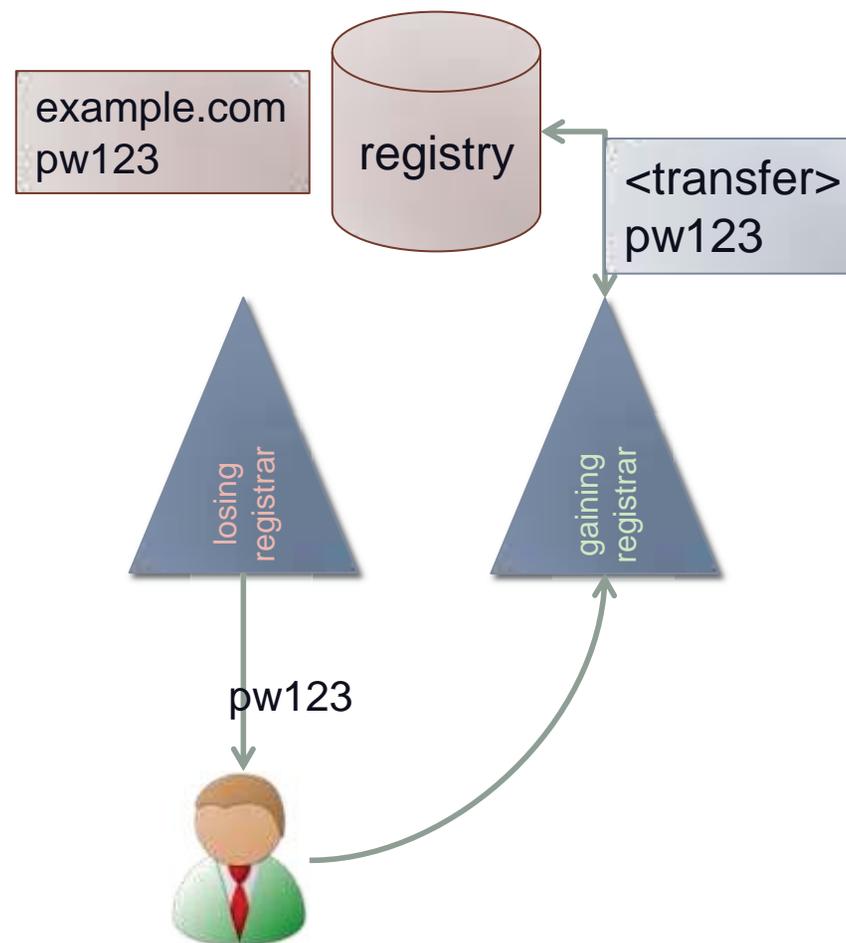
Domain Name: EXAMPLE.TLD  
Registry Domain ID: D1234567-TLD  
Registrar WHOIS Server: whois.example-registrar.tld  
Registrar URL: http://www.example-registrar.tld  
Updated Date: 2009-05-29T20:13:00Z  
Creation Date: 2000-10-08T00:45:00Z  
Registrar Registration Expiration Date: 2010-10-08T00:44:59Z  
Registrar: EXAMPLE REGISTRAR LLC  
Registrar IANA ID: 5555555  
Registrar Abuse Contact Email: email@registrar.tld  
Registrar Abuse Contact Phone: +1.1235551234  
Reseller: EXAMPLE RESELLER<sup>1</sup>  
Domain Status: clientDeleteProhibited<sup>2</sup>  
Domain Status: clientRenewProhibited  
Domain Status: clientTransferProhibited  
Registry Registrant ID: 5372808-ERL<sup>3</sup>  
Registrant Name: EXAMPLE REGISTRANT<sup>4</sup>  
Registrant Organization: EXAMPLE ORGANIZATION  
Registrant Street: 123 EXAMPLE STREET  
Registrant City: ANYTOWN  
Registrant State/Province: AP<sup>5</sup>  
Registrant Postal Code: A1A1A1<sup>6</sup>  
Registrant Country: AA  
Registrant Phone: +1.5555551212  
Registrant Phone Ext: 1234<sup>7</sup>  
Registrant Fax: +1.5555551213  
Registrant Fax Ext: 4321  
Registrant Email: EMAIL@EXAMPLE.TLD  
Registry Admin ID: 5372809-ERL<sup>8</sup>  
Admin Name: EXAMPLE REGISTRANT ADMINISTRATIVE  
Admin Organization: EXAMPLE REGISTRANT ORGANIZATION  
Admin Street: 123 EXAMPLE STREET  
Admin City: ANYTOWN  
Admin State/Province: AP  
Admin Postal Code: A1A1A1

# Protocol ops: allocation

- Example: EPP operations (RFC 5730, 5731)
  - ENUM: RFC 4114
  - separate “contact” definition
- EPP operations
  - session **<login>**, **<logout>**
  - query **<check>**, **<info>**, **<poll>**, **<transfer>**
  - object **<create>**, **<delete>**, **<renew>**, **<transfer>**, **<update>**
- Additional authorization via HTTPS client certs or similar?
- *Is EPP sufficient as-is, extensible enough or structurally deficient?*

# Number porting models: token

- Transfer:
  - *registrar 1* → *registrar 2*
- Porting:
  - *provider 1* → *provider 2* (in EPP, that's an **<update>**)
- Token model (“AuthInfo” in EPP)
  - current registrar provides secret token to assignee
  - assignee provides token to gaining registrar/carrier



# Porting: other models

- Add neutral third party (TPV)
  - gaining registrar/carrier transfers request to neutral 3<sup>rd</sup> party
  - 3<sup>rd</sup> party validates request
  - passes validated request to carrier (registrar? registry?)
- User certificate: sign transfer request
- OAuth
- Others?

# Caching

- Caching can improve performance and increase resiliency
- But: porting and other change events need to be visible quickly
  - how quickly – seconds? minutes? hours?
  - 1.48 million porting events / day (10% user-initiated)
    - → 1.7 user events/second or (roughly) 136 bps
    - very roughly 0.1% of all assigned numbers
- Caching approaches:
  - **Passive**: explicit expiration time
  - **Active**: publish-subscribe notification of registrars and other entities for numbers they care about → cache invalidation
    - can “push” cache invalidation scale?

# Role of caller location in numbering

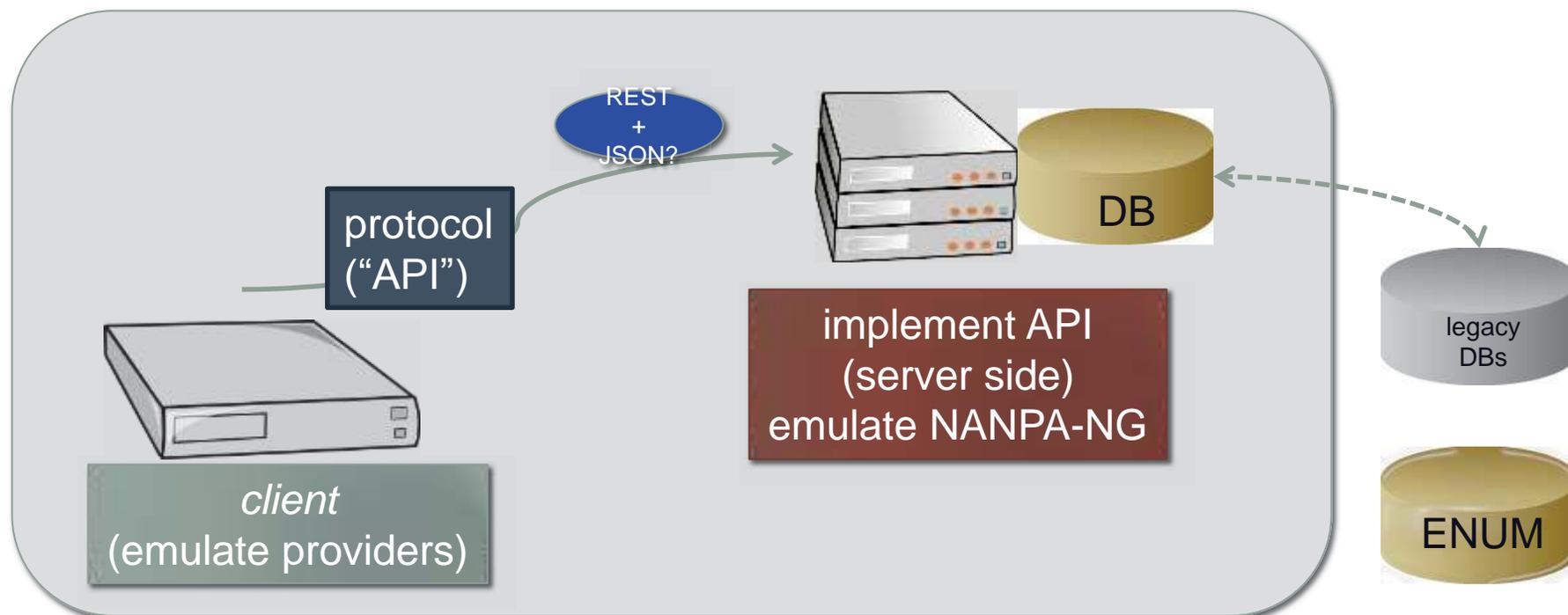
- 800# allow location-specific (shared) use
- Does the architecture need to support this?
- At what granularity?
- Can this be used to simplify nationwide 211, 311 & 511?

TESTBED

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## Test bed for exploring numbering issues

- MOADB, JIT, ENUM, STIR, ... → move from reports to prototypes and testing
- neutral, non-production, collaborative, non-legacy
- enable many parallel approaches



# Test bed issues

- Mainly need common data store
  - just SQL access?
- Who operates the test bed?
  - gov: NSF GENI, DHS DETER, FCC
  - industry sponsor(s)
- “Code of conduct” (AUP)?
- Technical requirements
- “Governance” – e.g., schema changes

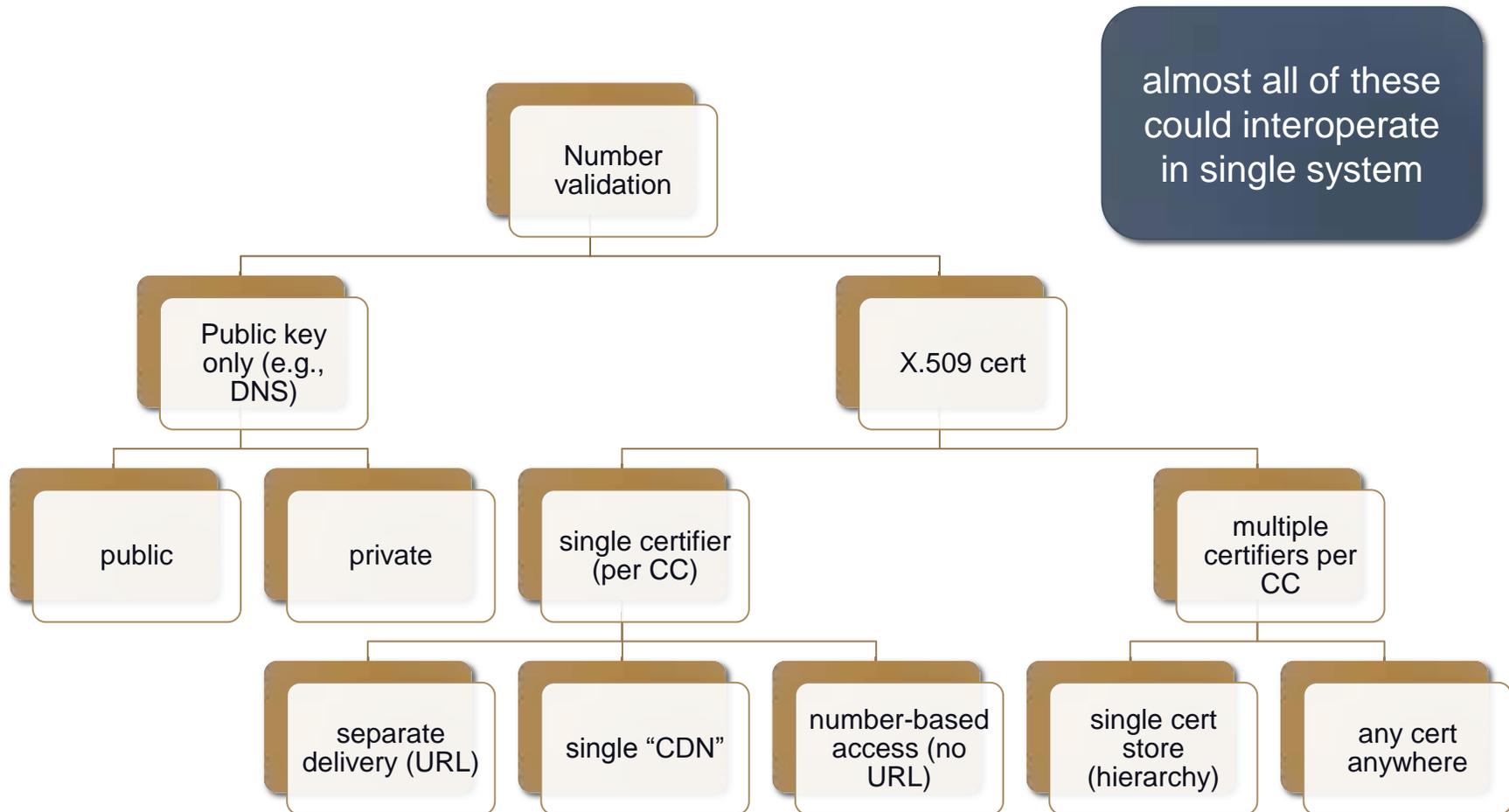
## Next steps

- Summary report for workshop
- Mailing list?
- Regular group meetings?
- Hand-off to SDO processes?

# BACKUP

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# Key management options

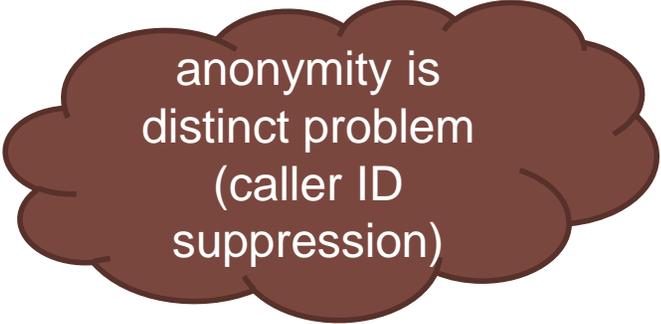


# Certificate models

- *Integrated* with number assignment
  - assignment of number includes certificate: “public key X is authorized to use number N”
  - issued by number assignment authority (e.g., NPAC), possibly with delegation chain
    - allocation entity → carrier (→ end user)
- *separate* proof of ownership
  - similar to web domain validation
  - e.g., similar to Google voice validation by automated call back
    - “Enter the number you heard in web form”
  - Automate by SIP OPTIONS message response?

# Legitimate caller ID spoofing

- Doctor's office
  - call from personal physician cell phone should show doctor's office number
- Call center
  - airline outbound contract call center should show airline main number, not call center
- Multiple devices, one number
  - provide single call-back number (e.g., some VoIP services) from all devices



anonymity is  
distinct problem  
(caller ID  
suppression)

# EPP Command Example

```
<?xml version="1.0" standalone="no"?>
<epp xmlns="urn:iana:xmlns:epp"
      xmlns:xsi="http://www.w3.org/1999/XMLSchema-instance"
      xsi:schemaLocation="urn:iana:xmlns:epp epp.xsd">
  <command>
    <ping>
      <domain:ping xmlns:domain="urn:iana:xmlns:domain"
                  xsi:schemaLocation="urn:iana:xmlns:domain domain.xsd">
        <domain:name>example1.com</domain:name>
        <domain:name>example2.com</domain:name>
        <domain:name>example3.com</domain:name>
      </domain:ping>
    </ping>
    <trans-id>
      <date>2000-06-08</date>
      <client-id>ClientX</client-id>
      <code>ABC-12345-XYZ</code>
    </trans-id>
  </command>
</epp>
```

# EPP Response Example

```
<?xml version="1.0" standalone="no"?>
<epp xmlns="urn:iana:xmlns:epp"
  xmlns:xsi="http://www.w3.org/1999/XMLSchema-instance"
  xsi:schemaLocation="urn:iana:xmlns:epp epp.xsd">
  <response>
    <result code="1000">
      <text>Command completed successfully</text>
    </result>
    <response-data>
      <domain:ping-data xmlns:domain="urn:iana:xmlns:domain"
        xsi:schemaLocation="urn:iana:xmlns:domain domain.xsd">
        <domain:name result="known">example1.com</domain:name>
        <domain:name result="unknown">example2.com</domain:name>
        <domain:name result="known">example3.com</domain:name>
      </domain:ping-data>
    </response-data>
    <trans-id>
      <date>2000-06-08</date>
      <client-id>ClientX</client-id>
      <code>ABC-12345-XYZ</code>
    </trans-id>
  </response>
</epp>
```