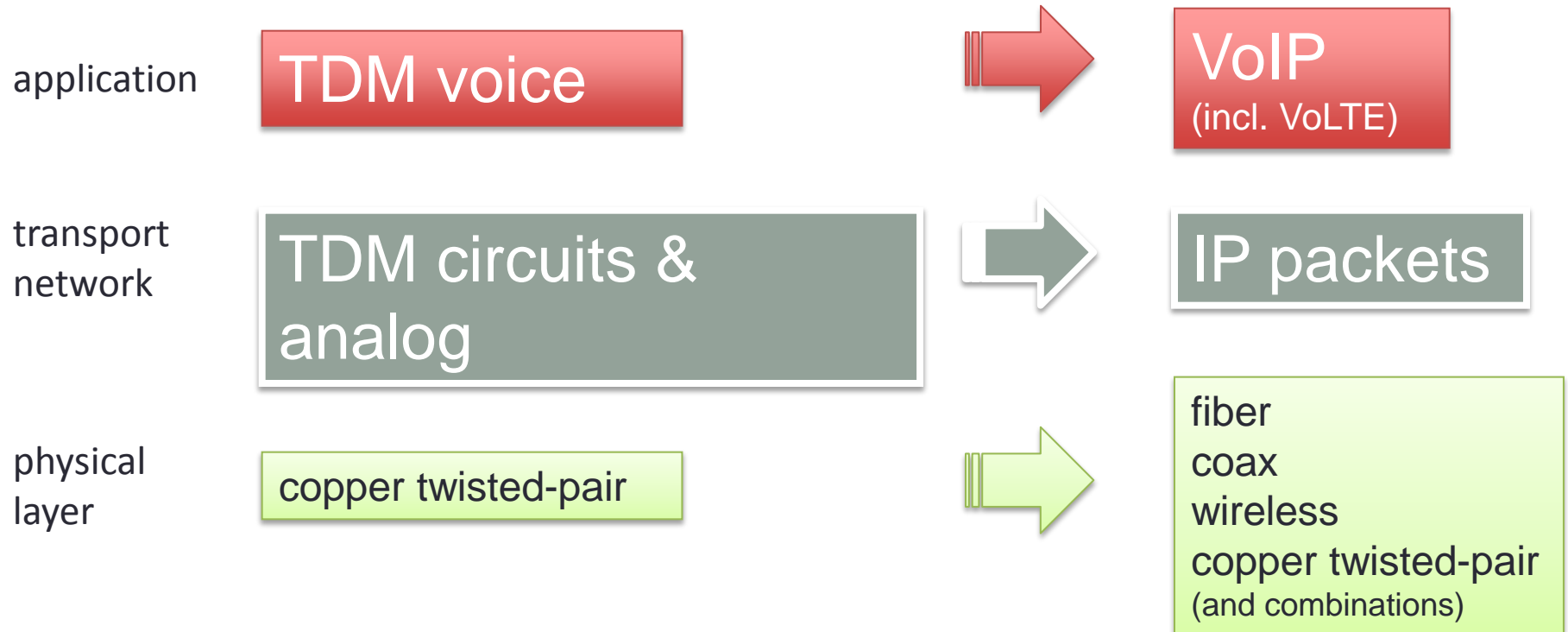# TECHNOLOGY TRANSITION: NUMBERING

Henning Schulzrinne

FCC

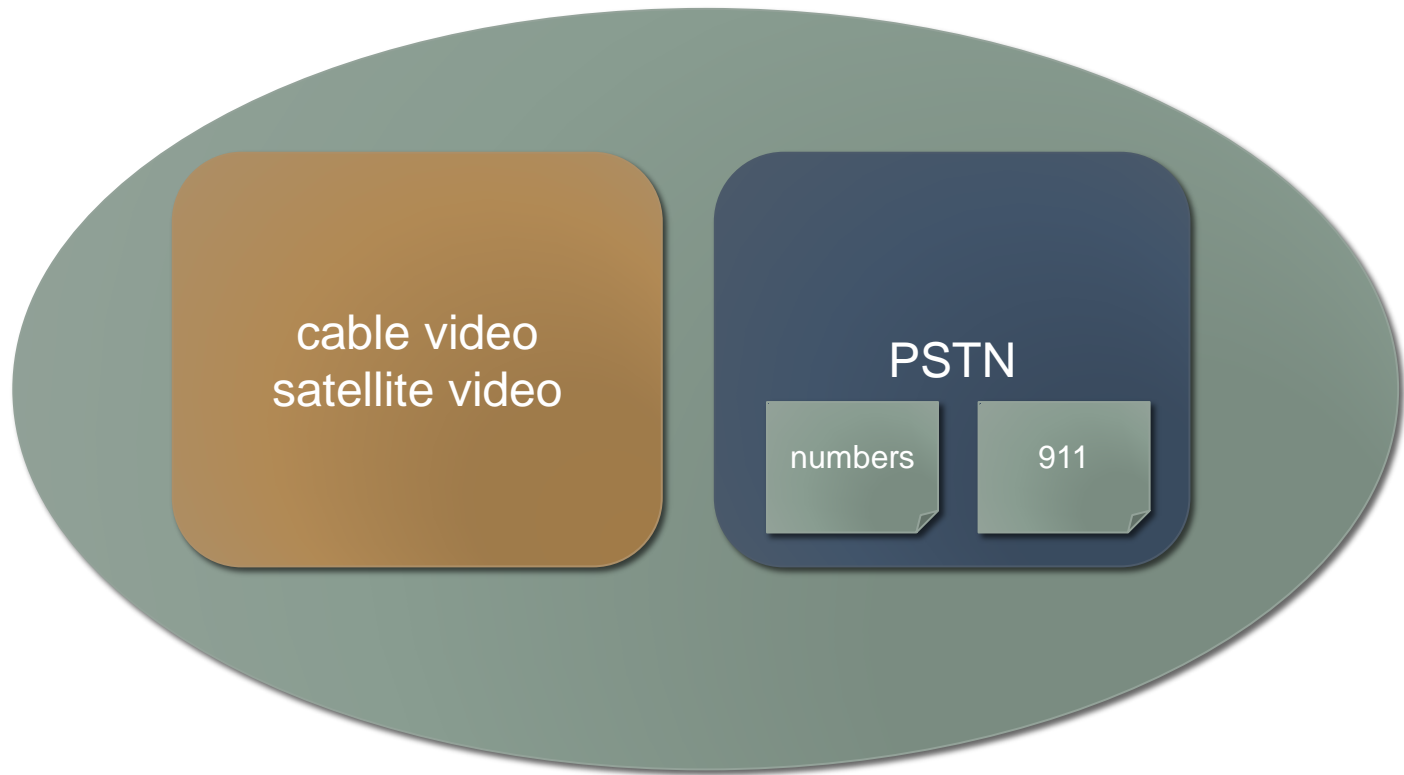# Overview

- Technology transition overview
- The role of telephone numbers
- The future of telephone numbers

# Technology Transitions

application　　TDM voice　→　VoIP (incl. VoLTE)

transport network　　TDM circuits & analog　→　IP packets

physical layer　　copper twisted-pair　→　fiber
coax
wireless
copper twisted-pair
(and combinations)

The universe of IP transitions

The three transitions

| From	to	motivation	issues
Copper	→ fiber	capacity maintenance cost	competition ("unbundled network elements")
Wired	→ wireless	mobility cost in rural areas	capacity quality
Circuits	→ packets (IP)	flexibility cost per bit	line power

VoIP, VoLTE

Dividing the problem space
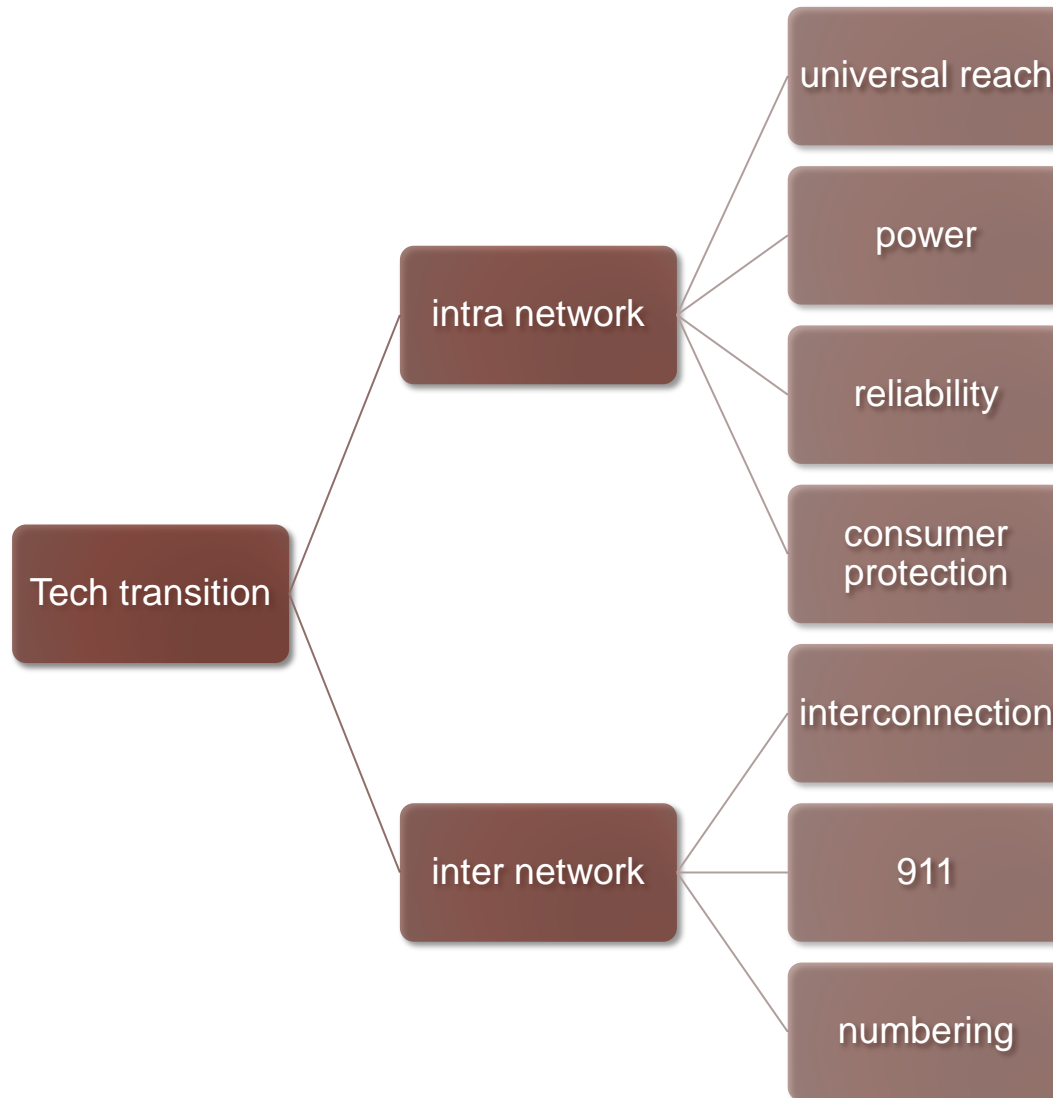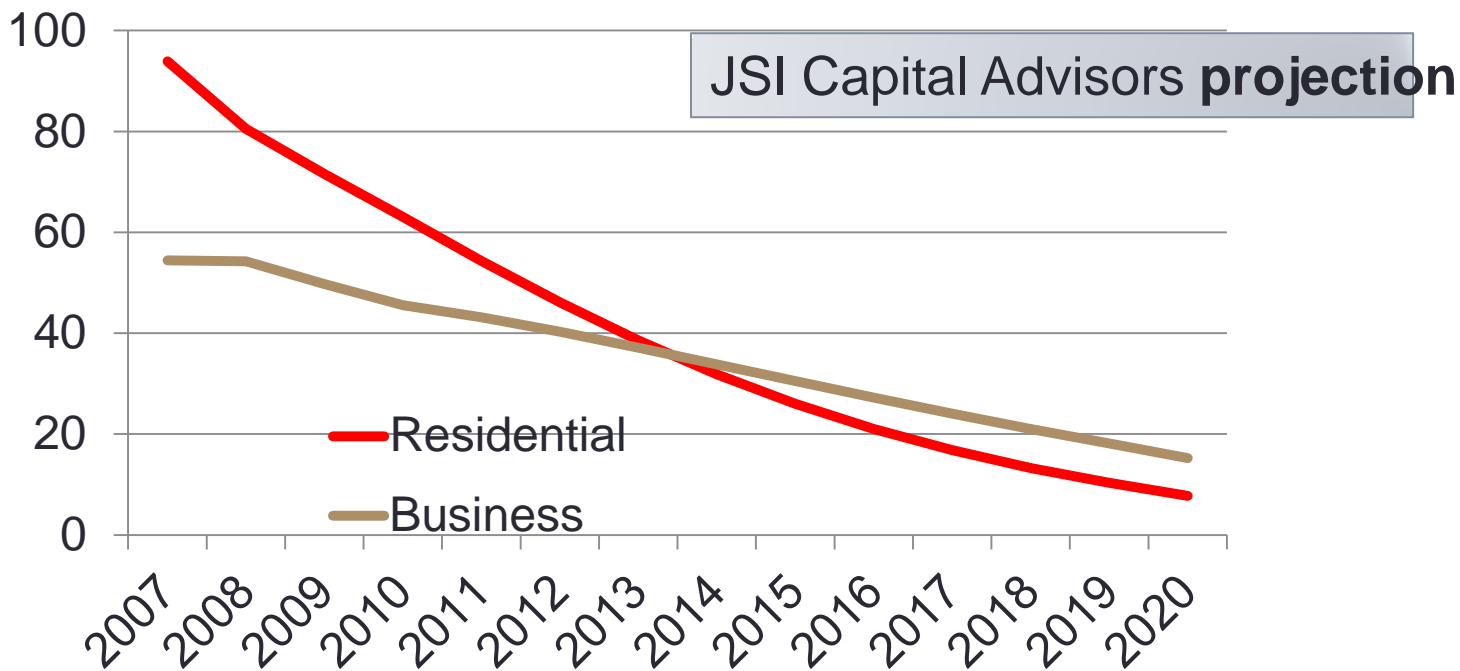
Interstate switched access minutes

Chart 5.1
Interstate Switched Access Minutes of Use for Incumbent Local Exchange Carriers
(in Billions)
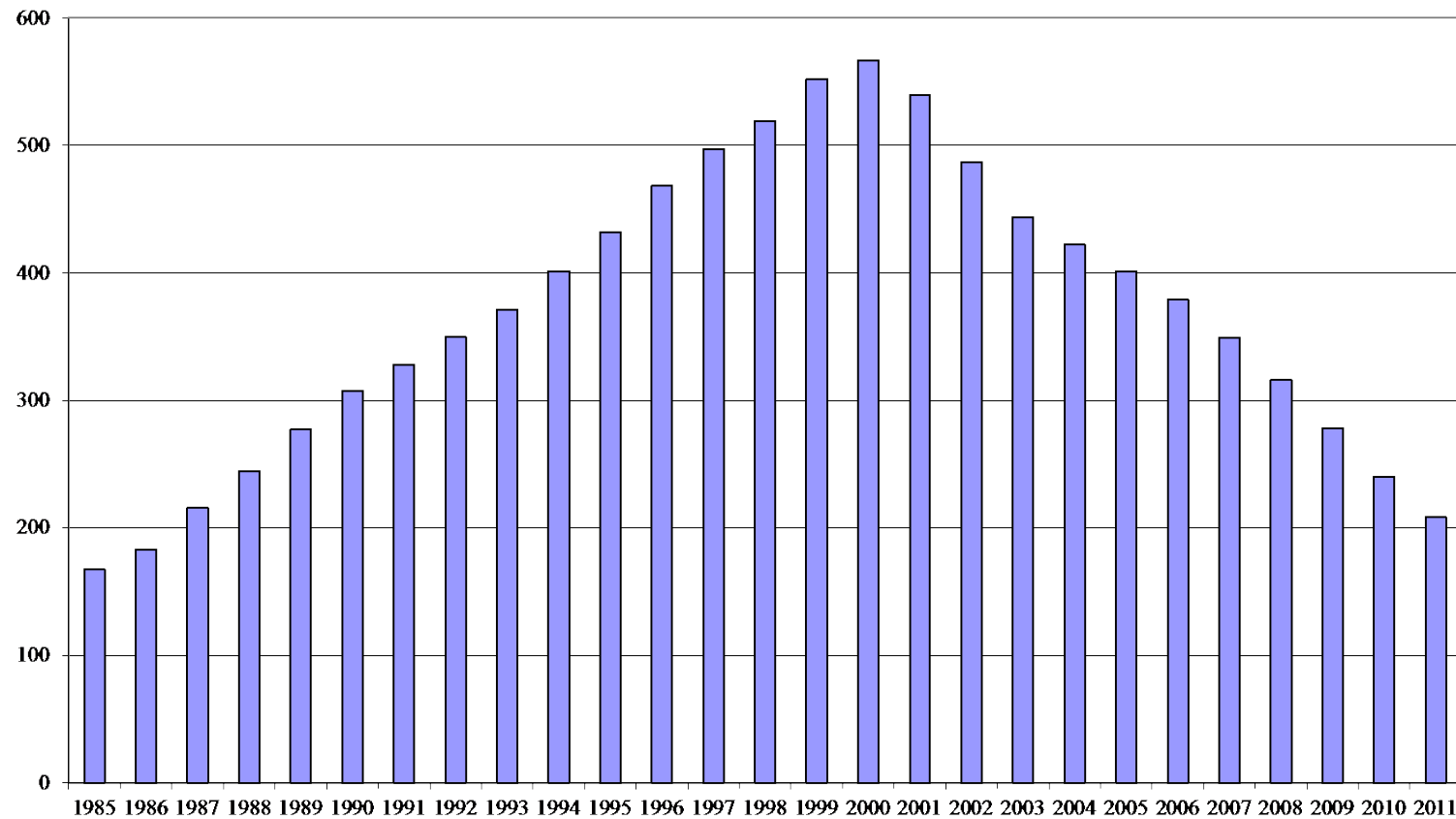
Source: National Exchange Carrier Association, various filings.

Lines are disappearing, but maintenance costs are constant

JSI Capital Advisors **projection**

voice only
(DSL: 20 M)

Residential

Business

per-line monthly maintenance cost

$2.72

$17.57

voice revenue/line: $50

dis

Switches are ageing

1979

Nortel DMS-100

http://www.phworld.org/switch/ntess.htm

Engines for tech transition

- Consumer-induced
  - Landline → cellular
    - uneven by geography, income, ethnicity
    - but decreasing rate
    - why do household keep or abandon landlines?
  - ILEC DSL → cable company for broadband
    - With bundled VoIP products
  - International calls → Skype, FaceTime, WhatsApp, …
  - PBX & Centrex → SIP trunking
- Carrier-induced
  - VoLTE for 4G cellular
  - central office upgrades (including analog access + VoIP backend)
  - conversion from copper to fiber or fixed wireless (but not all fiber is VoIP…)
- Much more consumer than business

Landline to cellular transition

47.1

39.1

ess service only

NUMBERS: DISAPPEARANCE OF THE OLD CONSTRAINTS

Communication identifiers

Property	URL owned	URL provider	E.164	Service-specific
Example	alice@smith.name sip:alice@smith.name	alice@gmail.com sip:alice@ilec.com	+1 202 555 1010	www.facebook.com/alice.example
Protocol-independent	no	no	yes	yes
Multimedia	yes	yes	maybe (VRS)	maybe
Portable	yes	no	somewhat	no
Groups	yes	yes	bridge number	not generally
Trademark issues	yes	unlikely	unlikely	possible
Privacy	Depends on name chosen (pseudonym)	Depends on naming scheme	mostly	Depends on provider "real name" policy

It's just a number

Number	Type	Problem
201 555 1212	E.164	same-geographic different dial plans (1/no 1, area code or not) text may or may not work
#250, #77, *677	voice short code	mobile only, but not all no SMS
12345	SMS short code	SMS only unclear where (country?) it works
211, 311, 411, 911	N11 codes	Distinct call routing mechanism Mostly voice-only May not work for VoIP or VRS
800, 855, 866, 877, 888	toll free	not toll free for cell phone may not work internationally
900	premium	voice only unpredictable cost

Telephone numbers

- Why are they important?
  - Universal public communication identifier → reachability
  - Scarce resource → area code splits, number exhaust
  - Allow for provider competition → number porting
- What are the facets of numbers?
  - addressing
  - translation (identifier → communication endpoint)
  - administration: assignment, recovery (pooling administrator)
  - security → prevent caller ID spoofing
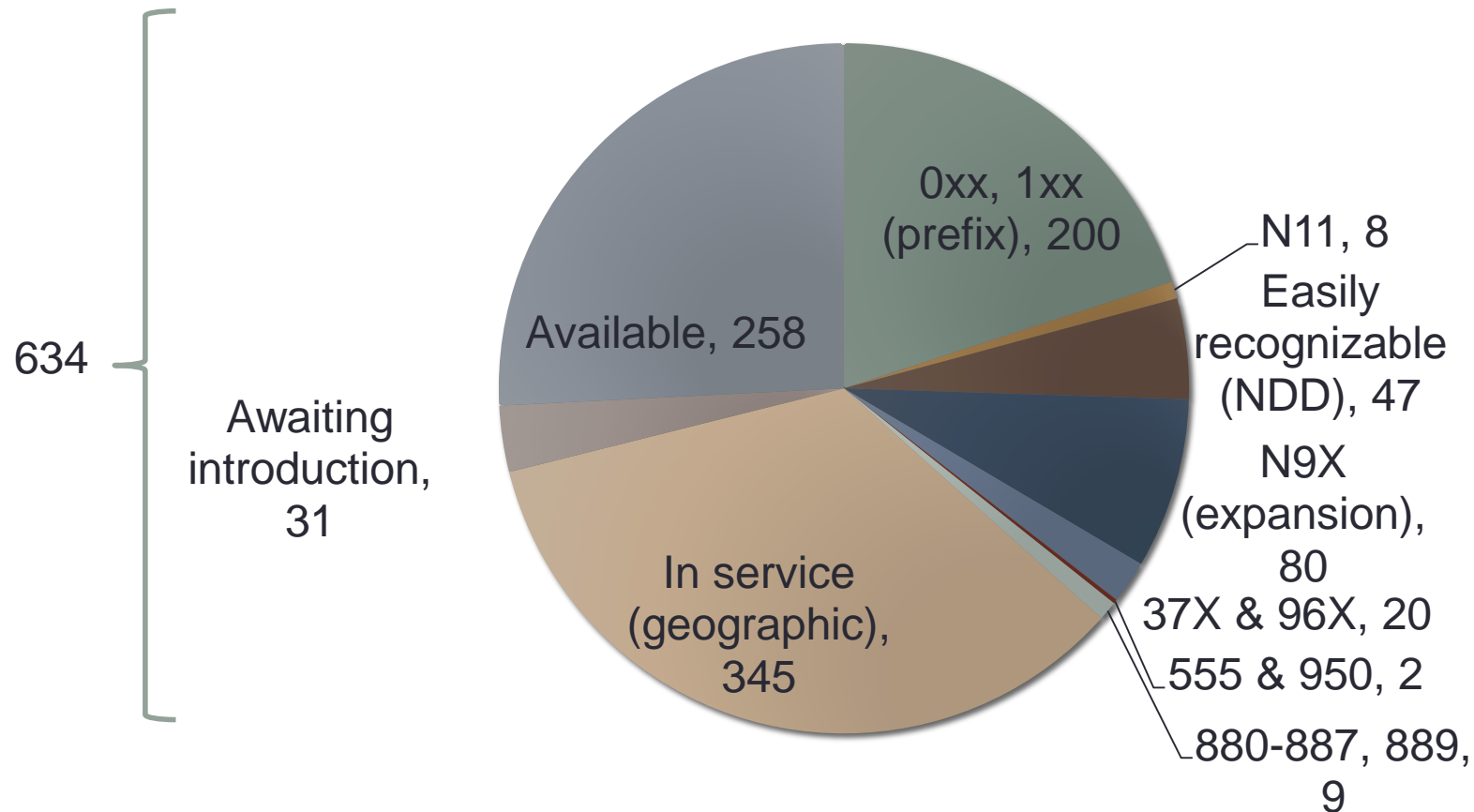
Numbers vs. DNS & IP addresses

	Phone #	DNS	IP address
Role	**identifier** + locator	identifier	**locator** (+ identifier)
Country-specific	mostly	optional	no
# of devices / name	1 (except Google Voice)	any	1 (interface)
# names /device	1 for mobile	any	any
controlled by	carrier, but portability unclear (800#) and geo. limited	any entity, with trademark restrictions	any entity (ISP, organization)
who can obtain?	geographically-constrained, currently carrier only	varies (e.g., .edu & .mil, vs. .de)	enterprise, carrier
porting	complex, often manual; wireless-to-wireline may not work	about one hour (DNS cache)	if entity has been assigned PIAs
delegation	companies (number range)	anybody	subnets
identity information	carrier (OCN), billing name only → LERG, LIDB	WHOIS data (unverified)	RPKI, whois

Number usage

FCC 12-46

Area codes (NPAs)

634

Awaiting introduction, 31

Available, 258

0xx, 1xx (prefix), 200

N11, 8

Easily recognizable (NDD), 47

N9X (expansion), 80

37X & 96X, 20

555 & 950, 2

880-887, 889, 9

In service (geographic), 345

Phone numbers for machines?

< 2010

212 555 1212

500 123 4567
(and geographic numbers)

12% of adults

500 123 4567
533, 544

5 mio.

311,000   64 mio.

now: one 5XX code a year…
(8M numbers)

see Tom McGarry, Neustar

Tablet Shipments Worldwide, 2010, 2011 & 2016
millions of units

253.0

55.2

17.6

2010   2011   2016
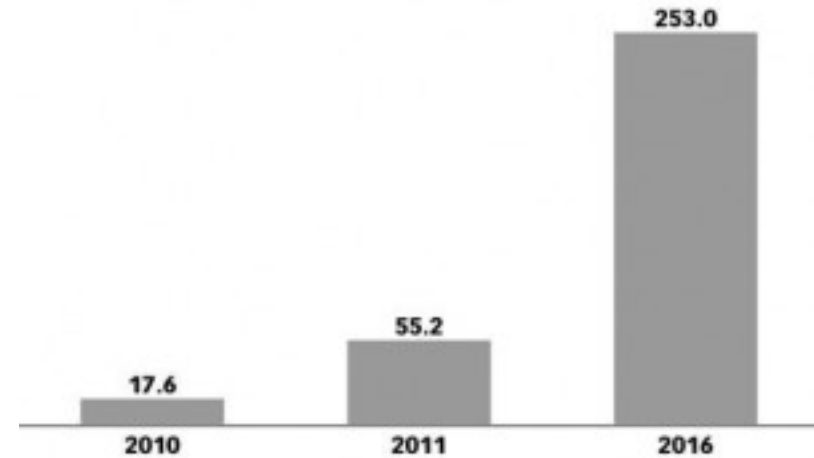
Source: Juniper Research, "Tablet & Ereader Evolution: Strategies &
Opporunities 2011-2016" as cited in "Viva la Evolution," Sep 21, 2011

132763   www.eMarketer.com

10 billion available

Future of numbers

- Should telephone numbers be treated as names?
  - similar to Internet domain names?
  - "multi-homing": one number, multiple services
    - call forwarding
    - audio, video & text
  - separate numbers from service provision?
- Should numbers have a geographic component?
  - Is this part of a region's cultural identity?
  - Should 10-digit dialing be universal?
  - What about legacy concepts like rate centers and LATAs?

Some numbers are valuable

gothamist

OUR CITIES: ▼ POPULAR ADVERTISE MORE
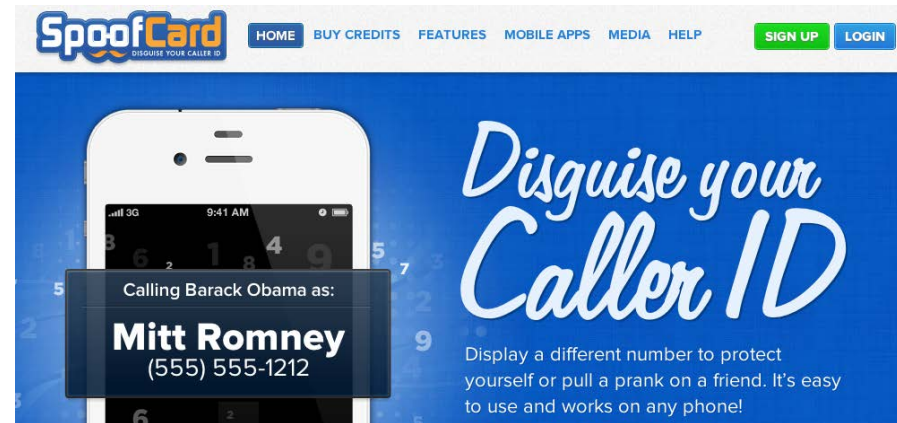
TRENDING: BUSKING MOSQUITOES 1970S RIDGEWOOD

212 Area Code Could Be Yours For One Million Dollars

Do you suffer from bad breath, low self-esteem, and unyielding, despondent loneliness? Do you long to be in the big game with the big players, way up high where it's always balmy, where no one snaps his fingers and says, "Hey, Shrimp, rack the balls!"? Well, sir/madam, pack your bags for Easy Street, because your ship has just come in: An area man has loosened his grip on a coveted 212 area code, and it could be yours on eBay today for just $1 million (or best offer)!
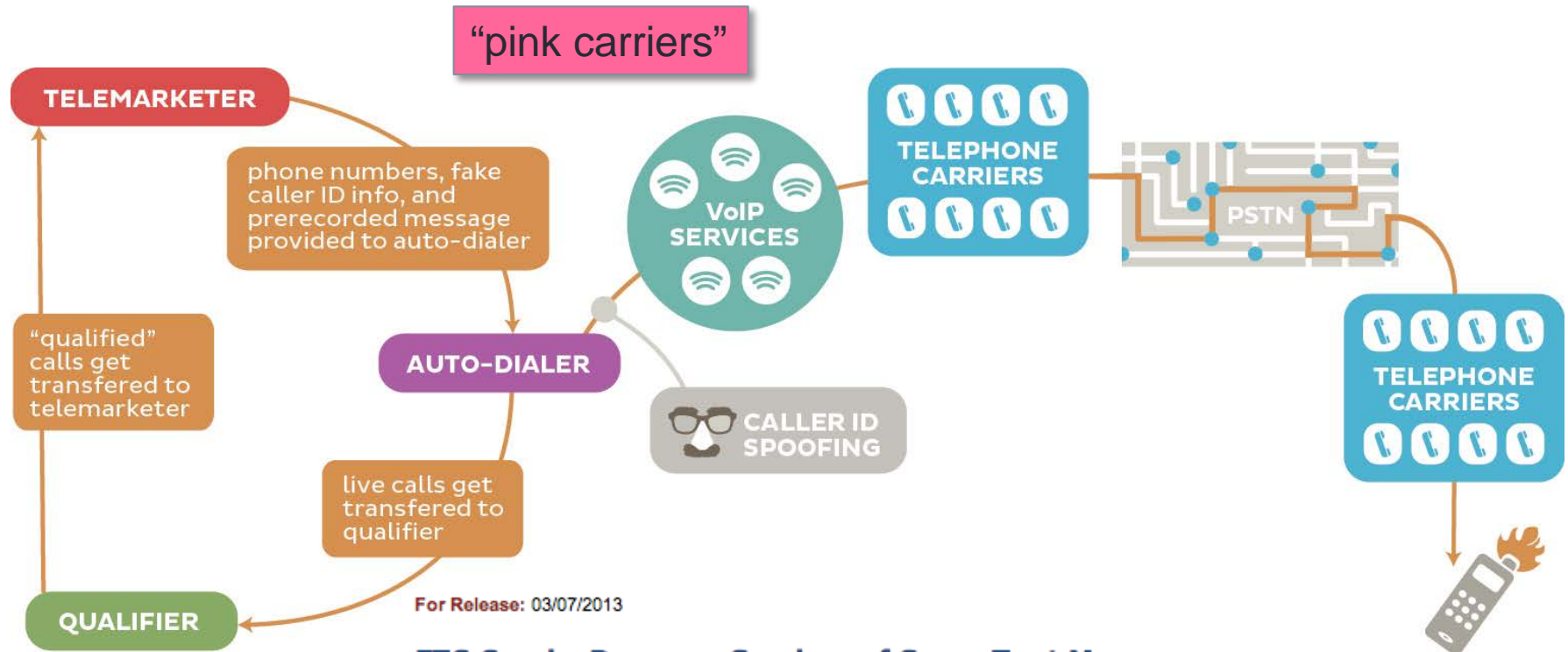
Caller ID spoofing

- Easily available on (SIP) trunks – can be legitimate
- Used for vishing, robocalling, swatting, anonymity breaking, …
- Caller ID Act of 2009: *Prohibit any person or entity from transmitting misleading or inaccurate caller ID information with the intent to defraud, cause harm, or wrongfully obtain anything of value.*
- Also: phantom traffic rules

Robocalling

"pink carriers"

TELEMARKETER

phone numbers, fake caller ID info, and prerecorded message provided to auto-dialer

"qualified" calls get transfered to telemarketer

AUTO-DIALER

VoIP SERVICES

TELEPHONE CARRIERS

PSTN

CALLER ID SPOOFING

live calls get transfered to qualifier

TELEPHONE CARRIERS

QUALIFIER

For Release: 03/07/2013

FTC Cracks Down on Senders of Spam Text Messages Promoting "Free" Gift Cards

Defendants Were Responsible for More than 180 Million Spam Text Messages

Three parts of phone number identity

initial effort

Phone number (CNG)
- nuisance call backs
- vishing

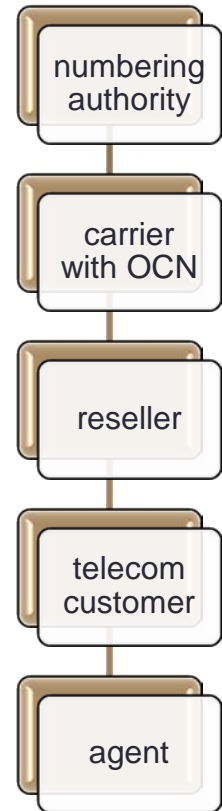**Textual caller ID**
- impersonation
- Citibank & Citybank

Properties
- registered charity
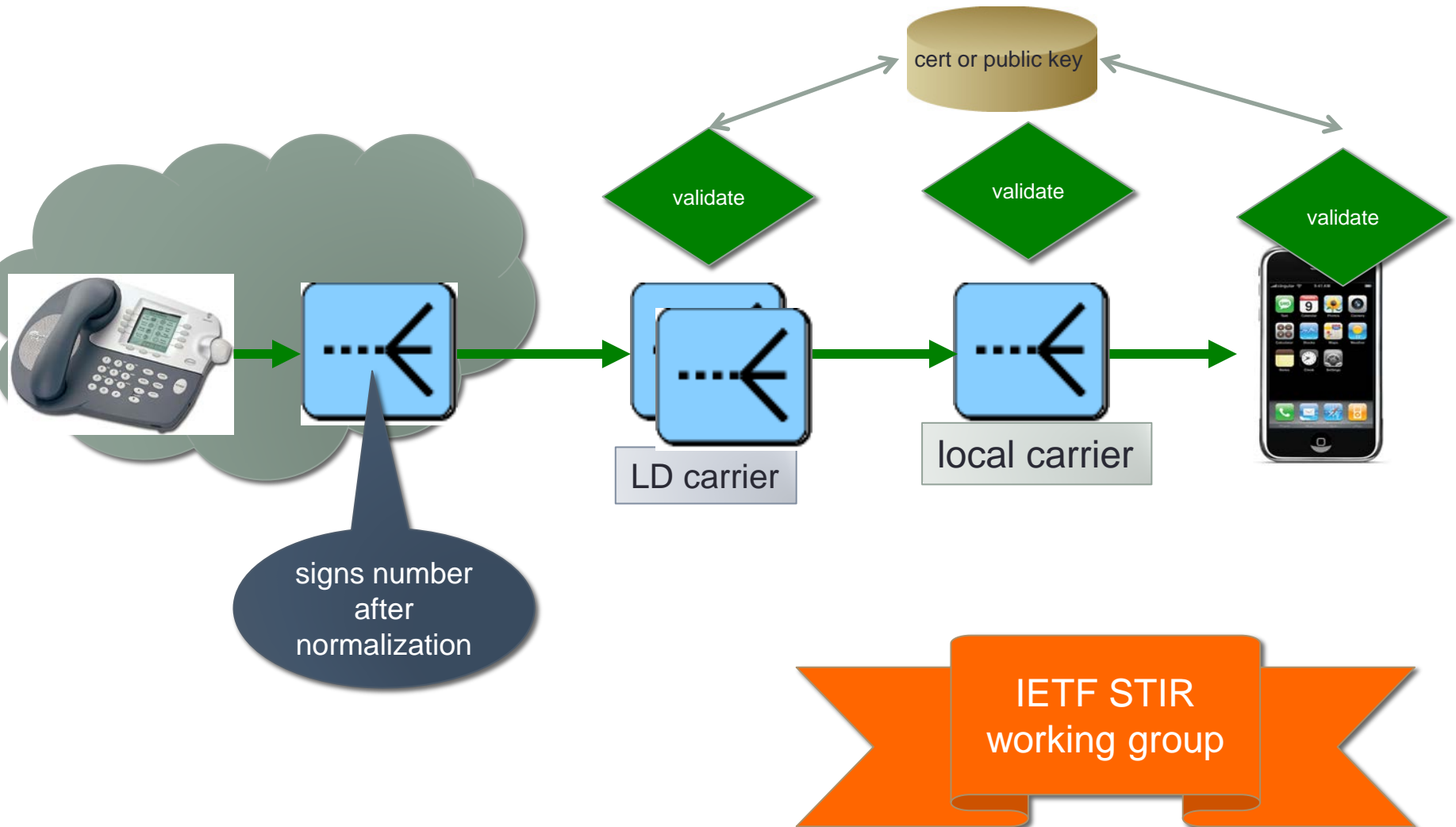- political candidate
- gov't agency
- bank

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

numbering authority

carrier with OCN

reseller

telecom customer

agent

Caller-ID validation architecture

cert or public key

validate

validate

validate

LD carrier

local carrier

signs number after normalization

IETF STIR working group
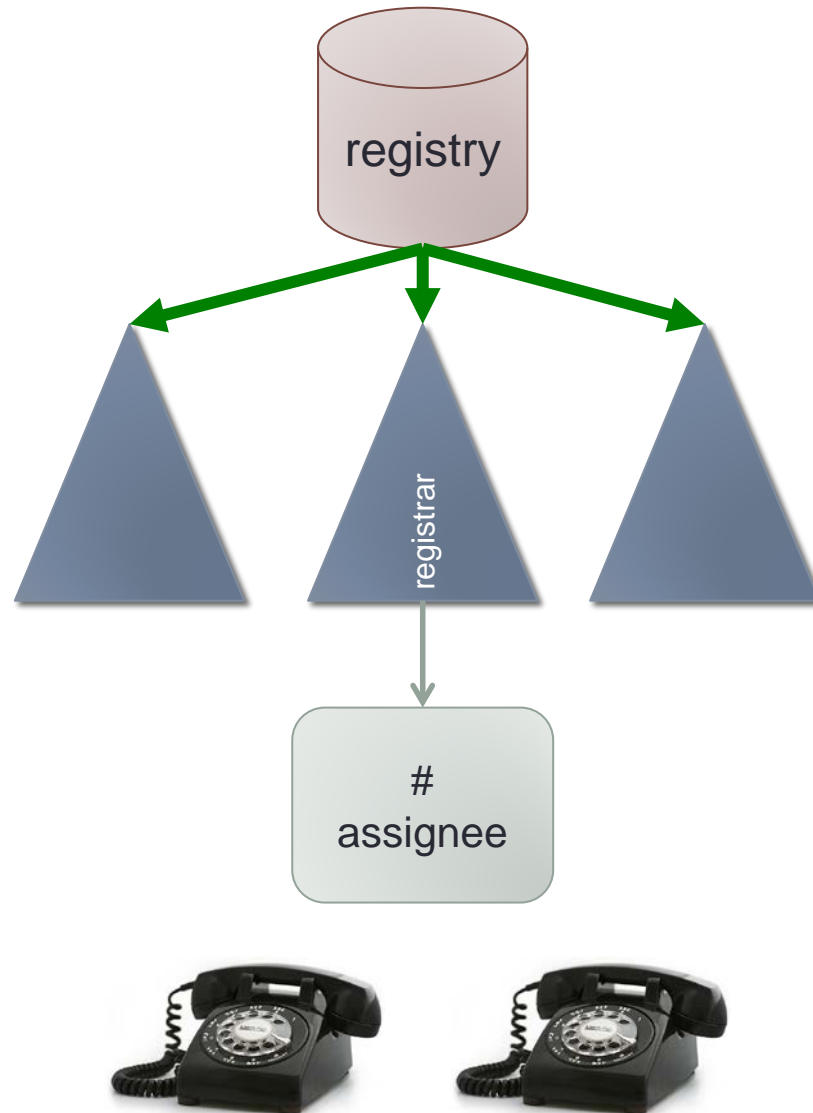
Future of number administration

- Is there a continued need to separate
  - NXX assignment (NANPA)
  - 1000-block assignment (pooling administrator)
  - number portability (NPAC)
- In VoIP, just need to map number to SIP URL(s)
- What are the interfaces we need for allocation?
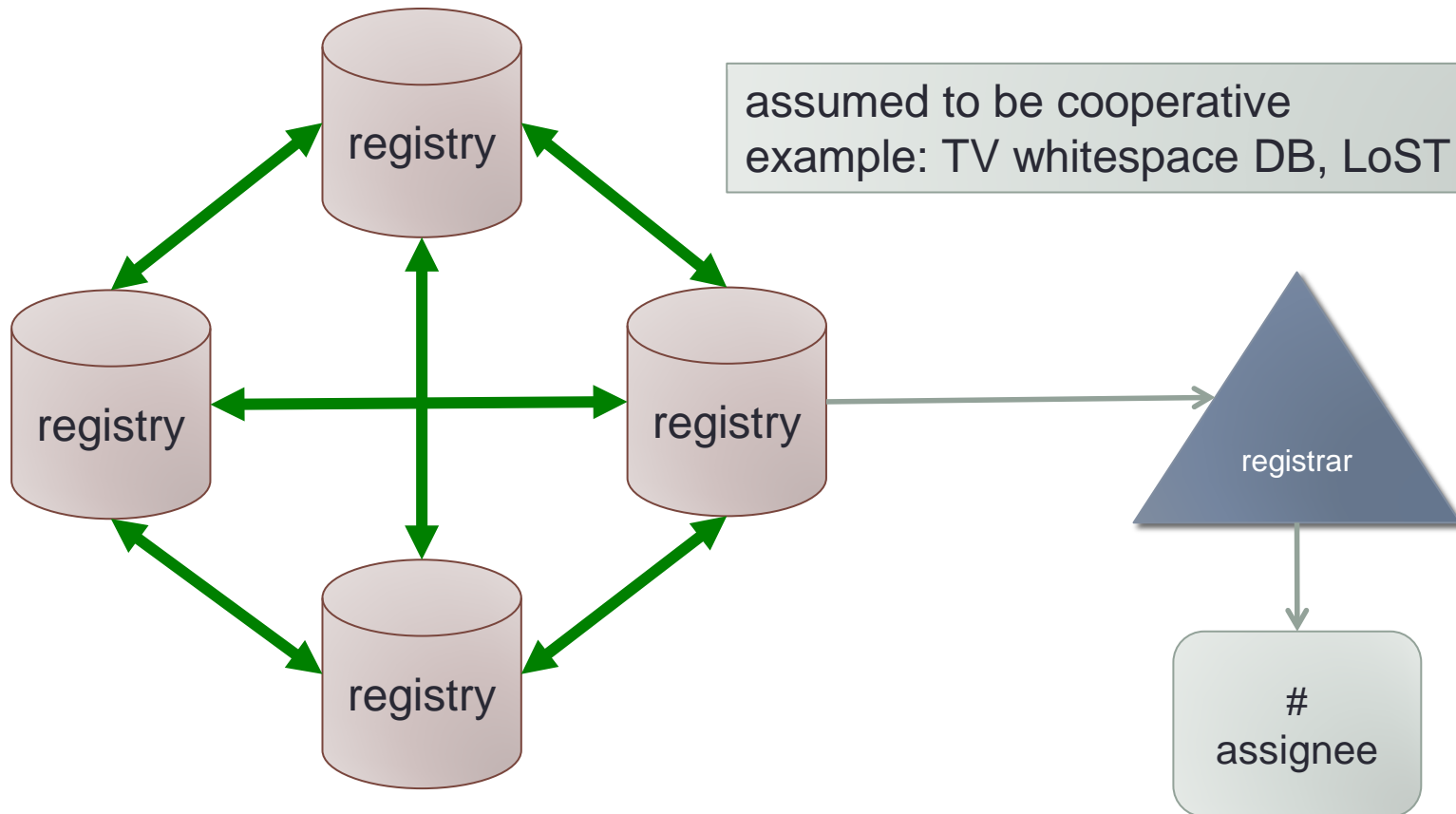
Reachability (SIP URL)

Assignment ("whois")

History

Assignment model 1: tree

Assignment model 2: mesh + tree

registry

registry

registry

registry

assumed to be cooperative
example: TV whitespace DB, LoST (NG911)

registrar

\#
assignee

Conclusion

- Convergence: all services are IP, just with different physical layers
  - but transitions are slow
- PSTN transition
  - some natural, some "induced"
  - intra and inter-network issues
- Numbers as crucial element of transition
  - universal, global identifier
  - scope-defining
- But we can make telephone numbers work better
  - better porting → facilitate consumer choice
  - higher security → trustable networks
  - lower overhead and complexity → higher reliability, lower barriers to entry