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# Pre-MODERN prototype

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# Overview

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## Overall objectives & architecture

- create toy version of fully functioning distributed number management system
- try out existing protocols for sub-functions
- key functions: allocation, porting and access to properties

## Paxos for distributed agreement

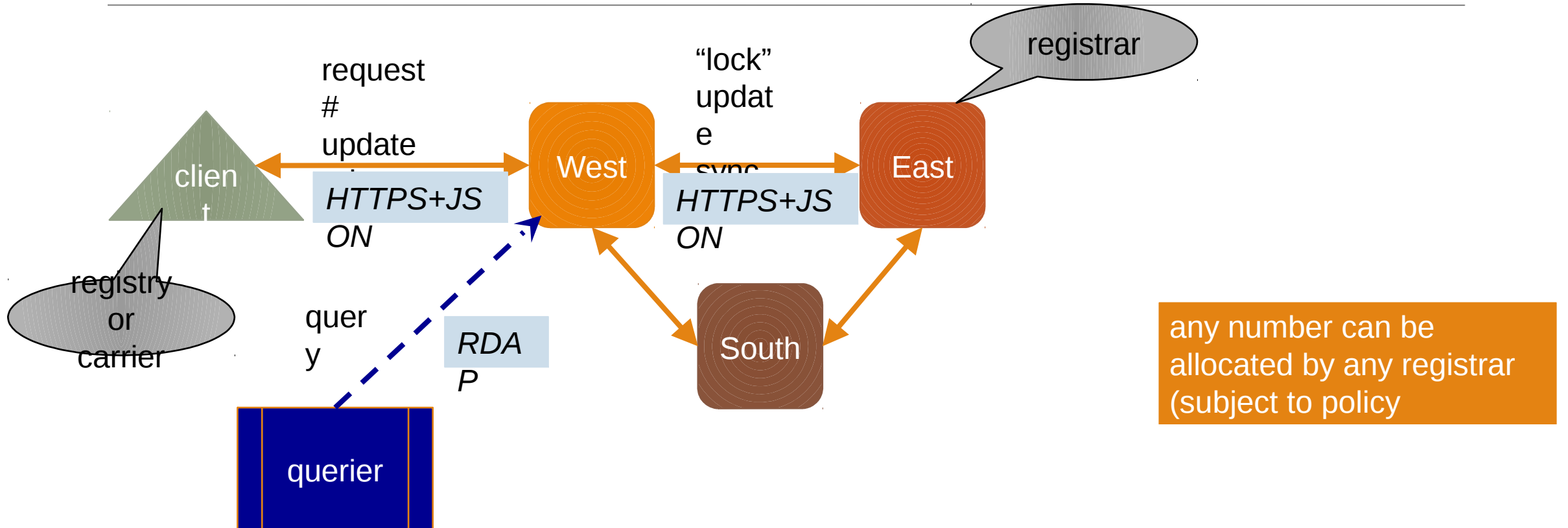
- ensure that each number (block) is only allocated once
- no hard limit on scale, but likely  $\leq 20$  systems

## Out of scope:

- number assignment policies (who, what, when, for how long, for how many Kč)
- scaling → each registrar scales as needed
- legacy and ENUM interfaces

e164.space prototype

# Architecture



# Authorization model

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Each number has an OCN (→ carrier-related contact information)

- Each OCN has number administrators (human or API)
  - can change all information about number (routing, properties, ...)

Consumers have PINs for access and porting

- read access to “whois” properties
- provide PIN to gaining provider to allow changing OCN

# Operations needed

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Allocate new number from available pool

- first consensus
- then gossip result (replicate or forwarding)

Port a number (number → new OCN)

Synchronize two registrars → allow new registrar to join

- also handles case of longer-term network disruption
- “give me all updates after time T1”

# Paxos (& similar dist. consensus) assumptions

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## Processors

- ... operate at arbitrary speed.
- ... may experience failures.
- ... with stable storage may re-join the protocol after failures (following a crash-recovery failure model).
- ... do not collude, lie, or otherwise attempt to subvert the protocol (non-byzantine)

## Network

- Processors can send messages to any other processor.
- Messages are sent asynchronously and may take arbitrarily long to deliver.
- Messages may be lost, reordered, or duplicated.
- Messages are delivered without corruption.

A consensus algorithm can make progress using  $2F+1$  processors despite the simultaneous failure of any  $F$  processors.

# Paxos & variants

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Wikipedia

In order to guarantee safety, Paxos defines three safety properties and ensures they are always held, regardless of the pattern of failures:

## Non-triviality

- Only proposed values can be learned.

## Safety

- At most one value can be learned (i.e., two different learners cannot learn different values).

## Liveness(C;L)

- If value C has been proposed, then eventually learner L will learn some value (if sufficient processes remain non-faulty).

# Paxos for distributed consensus

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Collision (mainly) a problem during allocation of numbers

- assume that number holder will coordinate update operations
- but could apply distributed consensus to updates as well (→ overhead)

Any registrar can allocate any available number

Rely on quorum =  $N/2 + 1$

- $N$  (registrar count) is assumed to be known and relatively static
- does not need to track minute-by-minute liveness
- uses heartbeat



# Paxos

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1. *Proposer* tries to acquire leadership window for time period T (liveness window) → PREPARE
2. Other servers receive PREPARE and whether to grant leadership or not  
grant if no other node has requested leadership  
reply with PROMISE
3. If #(PROMISE) > quorum, proposer becomes leader for liveness window
4. Proposer sends ACCEPT to all other nodes
5. Other nodes respond with ACCEPTED [may be unnecessary for our case]

# Prototype (e164.space)

**+ NUM-ALLOC**

Home

Admin

**Number List**

- Add New Number
- Port A Number
- OCN List
- Area Code List
- Manage System and Number Admins
- Reset Password
- Edit Profile

[+ Add New](#)

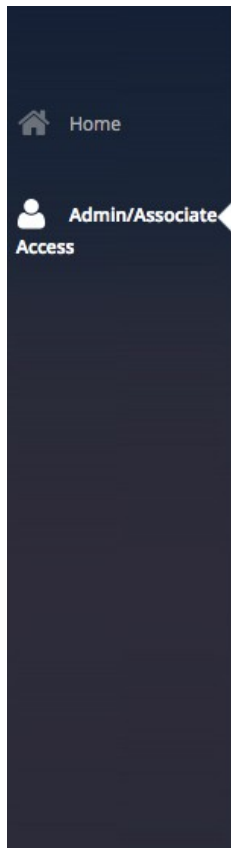
Show  entries

Search by Number, OCN, Location, SPID, or Service Indicator:

Number	CNAM	OCN	Assignee	Location	Collect	Service Indicator	Type	Log	View/Edit Entry?
2015926696	Henning Schulzrinne	1510	Columbia University	Leonia, NJ 07605, USA	allow	1	mobile	<a href="#">Log</a>	<a href="#">View/Edit</a>
2106396367	Akhilesh Mantripragada	42	China Tel. Co.	New York, NY 10025, USA	allow	Private	mobile	<a href="#">Log</a>	<a href="#">View/Edit</a>
2106396368	Akhilesh	42	Dixville Tel. Co.	New York, NY 10025, USA	allow	Private	mobile	<a href="#">Log</a>	<a href="#">View/Edit</a>
2106396369	Akhilesh 2	42	Dixville Tel. Co.	New York, NY 10025, USA	allow	Private	mobile	<a href="#">Log</a>	<a href="#">View/Edit</a>

# Prototype

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## Edit Details

**Alloted Number** 2015926696

**CNAM**  

**OCN Information**

**Assignee Information**

**Certificate** [Certificate Link](#)  No file chosen

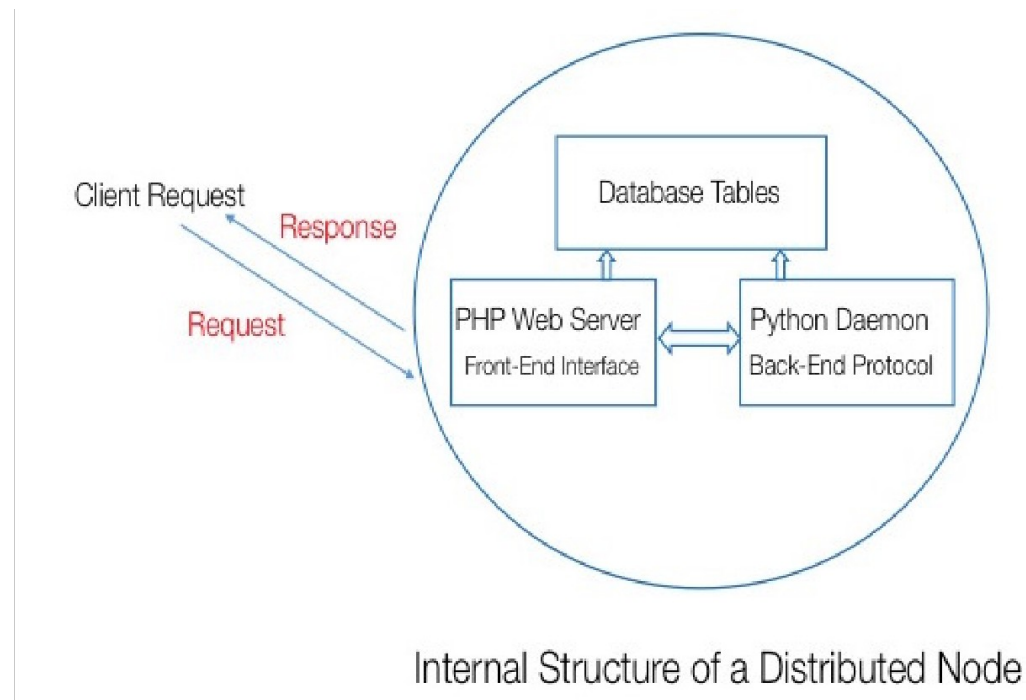
**Zip Code**

**Location**

**Operating Telephone Company (OTC)**

# Implementation

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# Implementation

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## Front end

- HTML 5
- CSS 3
- JavaScript/Jquery
- Twitter Bootstrap CSS

## Back end

- PHP with Laravel framework
- Python

## Database

- MySQL

## Development environment

- Version control: GitHub
- IDE: PHP Storm
- Hosting: Digital Ocean
- Testing: Codeception

## External APIs

- Google Maps, Mandrill, Twilio