



# DOA: Some Observations From ICANN Office of the CTO/Research

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# ICANN-OCTO/Research Engagement Since 2015

- The research branch of the Office of the CTO at ICANN started to look at DOA in 2015
- OCTO/Research had a number of interactions with Dr. Robert Kahn and his team at CNRI
- OCTO/Research obtained a prefix end of 2015 and have been running an experimental DOA server since OCTO/Research moved to server code version 8.1 in 2016
- Output: a number of memos to upper management and the board

# Caveat

Complete and up-to-date documentation of the DOA data format, protocols on the wire and/or security protocols does not appear to be publicly available.

The CNRI implementation is readily available, there might be others that we have not found.

As a result, it is not easy to separate what is protocol description from what is implementation choice. The following description correspond to our best efforts at understanding how DOA works and there might be errors.

# DOA: Digital Object Architecture

Invented by Dr. Robert Kahn, CNRI

## Multiple names:

- **Handle System**
- **DOI:** Digital Object Identifier (publishing industry)
- **DOA:** Digital Object Architecture
- **DONA:** Digital Object Network Architecture (the foundation)

## What does a handle look like? **prefix/local-name**

Examples:

11738/ithi



<https://www.icann.org/ithi>

10.1038/nphys1170 → <http://www.nature.com/nphys/journal/v5/n1/full/nphys1170.html>

## Handle syntax: prefix/local-name

Prefixes are dot separated UTF-8 strings. ***As of 2017, only digits are used***, except for special cases.

**11738**

zero-delimiter prefix

**10.1038**

one-delimiter prefix

**20.500.1234**

two delimiter prefix

As of 2016, new registrations can only be one-delimiter or more. The prefix 11738 was allocated by CNRI before the new regime and was grand-fathered in.

# Registration: MPA

**MPA** (Multi Primary Administrator) perform prefix registration (and resolution) in the Global Handle Registry.

Note: there does not appear to be any publicly available documentation on how to become an MPA or what the responsibilities are.

CNRI is the original/main MPA.

**CNRI registration cost as of 2016:**

\$50 One-time initial registration fee + \$50/year

As of 1/2017, sub-prefixes (e.g. 11738.1935) must be registered directly to the MPA.

**The DONA foundation** has been created to assume the governance role in DOA. It is based in Geneva, Switzerland. All intellectual property rights (IPR) have been transferred from CNRI to the DONA foundation.

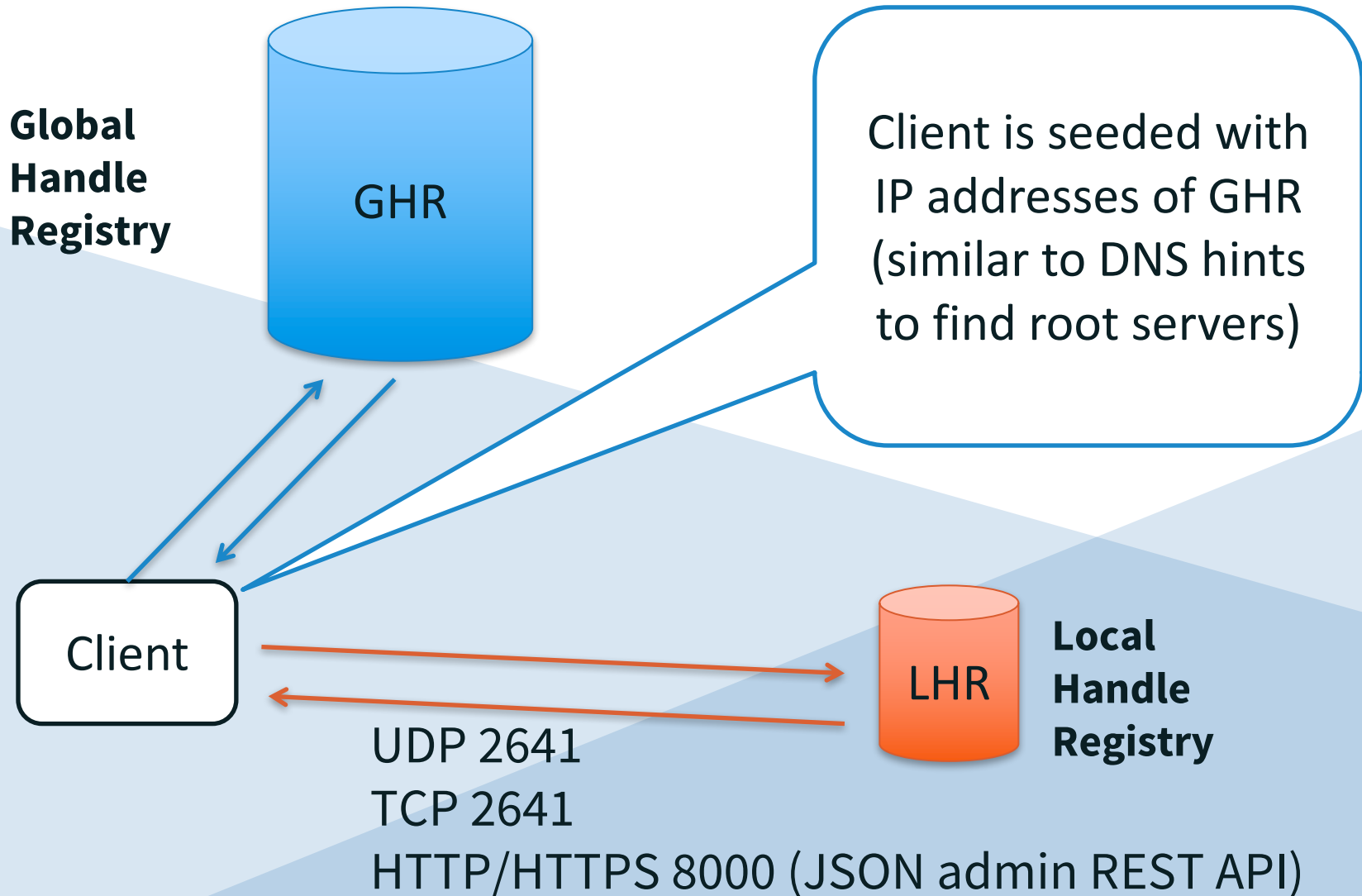
The DONA foundation assumes the combined roles of:

- **protocol evolution** (similar role as IETF does for DNS)
- **policy development** (similar role as ICANN does for DNS)
- **GHR operation** (similar role as root server operators do for DNS)

There is a **MoU between the DONA foundation and the ITU:**

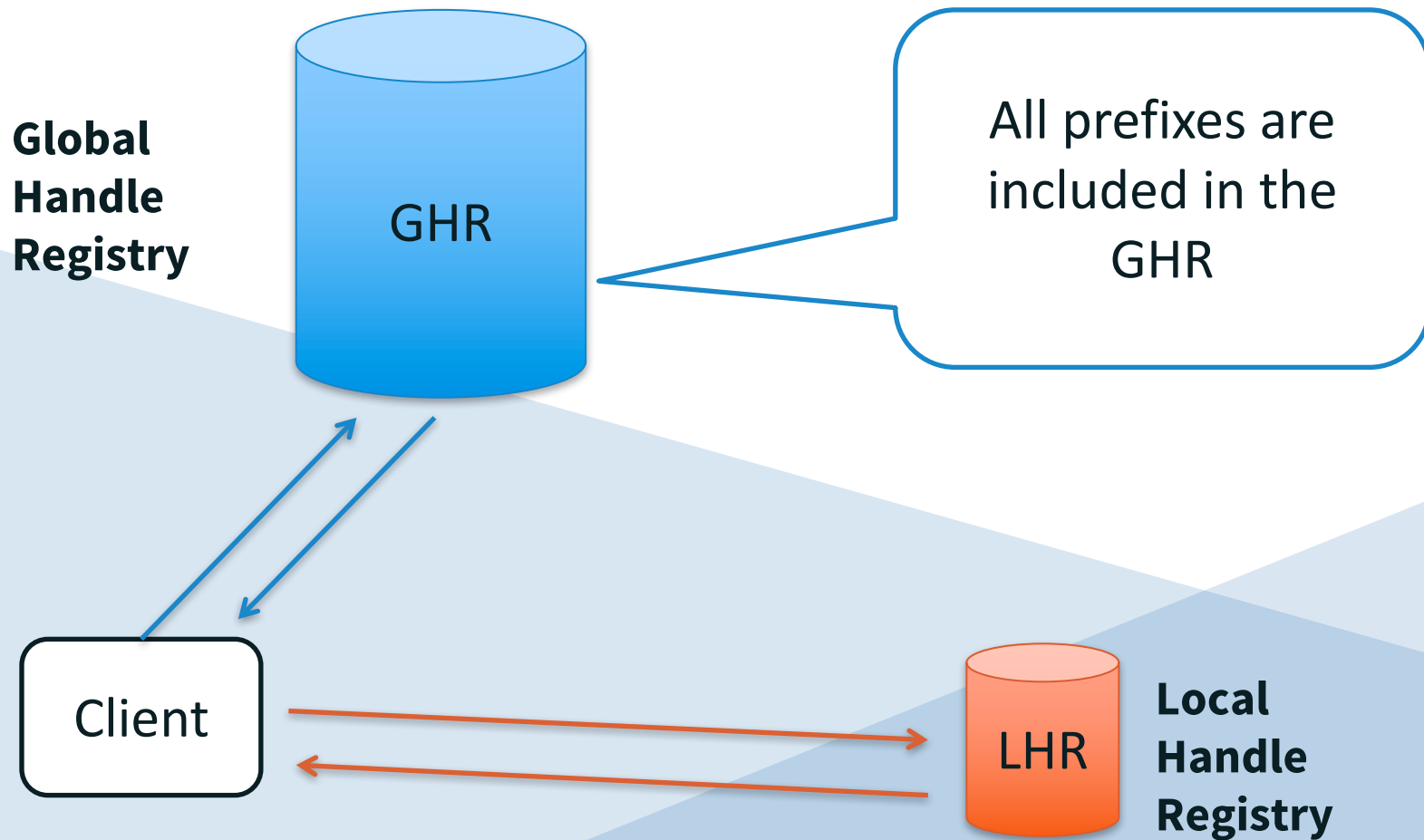
- ITU provide secretariat function
- **ITU will provide reconstruction in case of DONA failure**

# Resolution: Two Levels of Registry, GHR & LHR



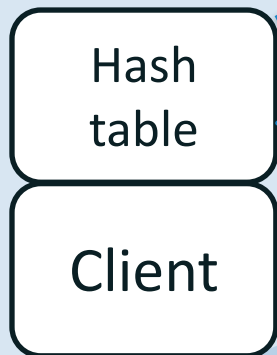
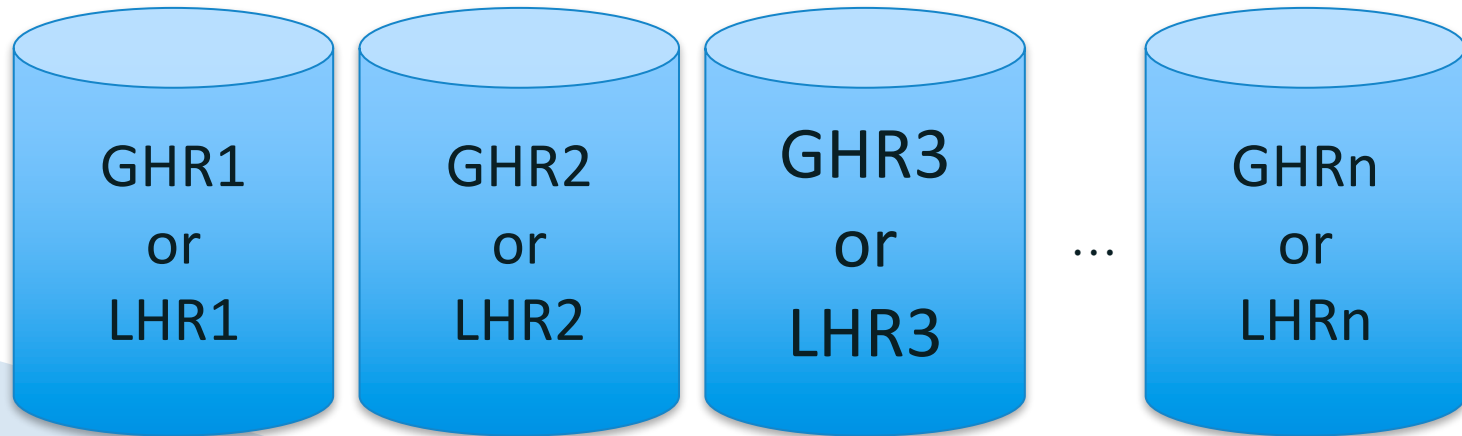


# Resolution /Scaling



# Resolution /Scaling (2)

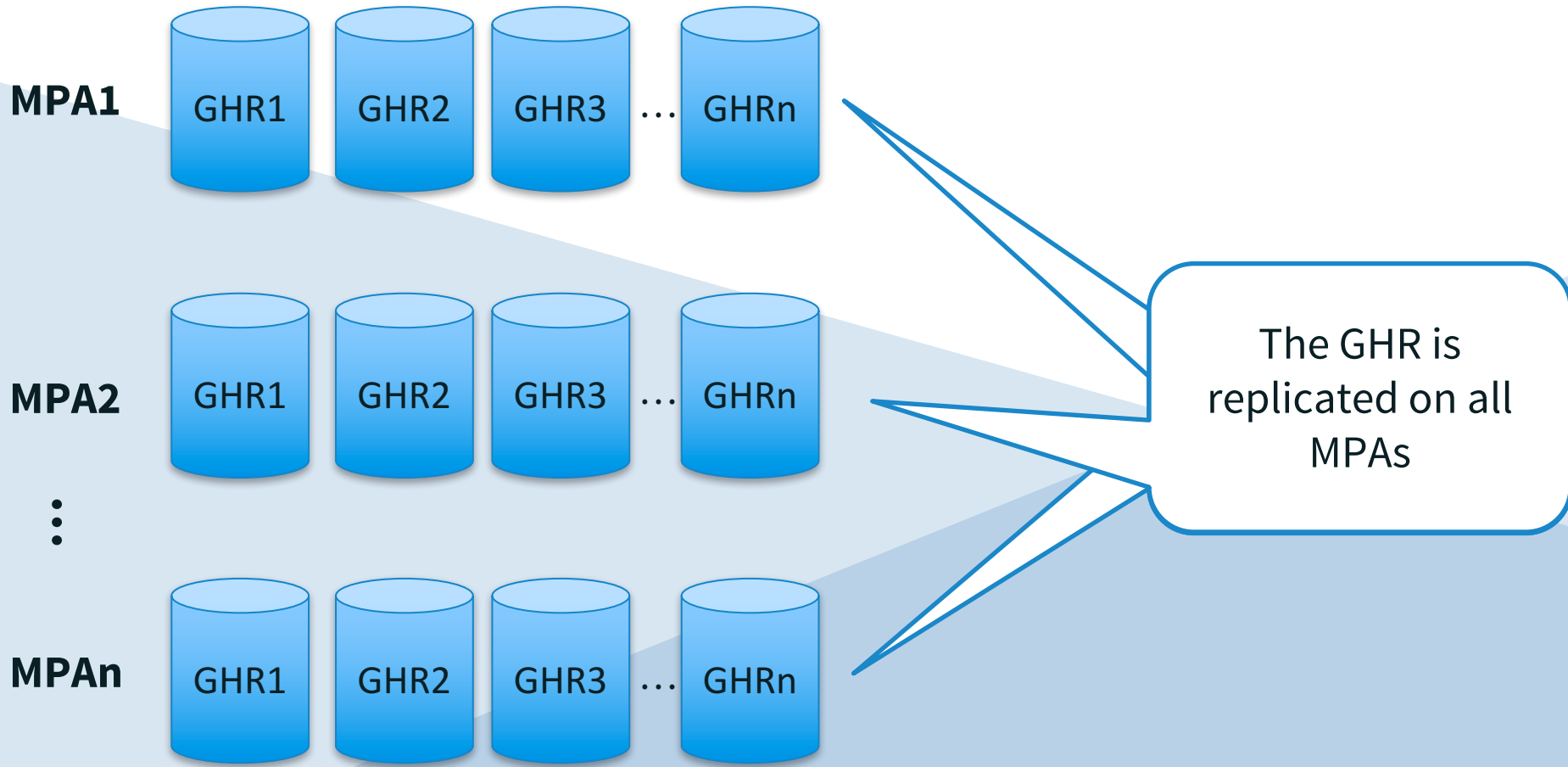
**Handle  
Registry**



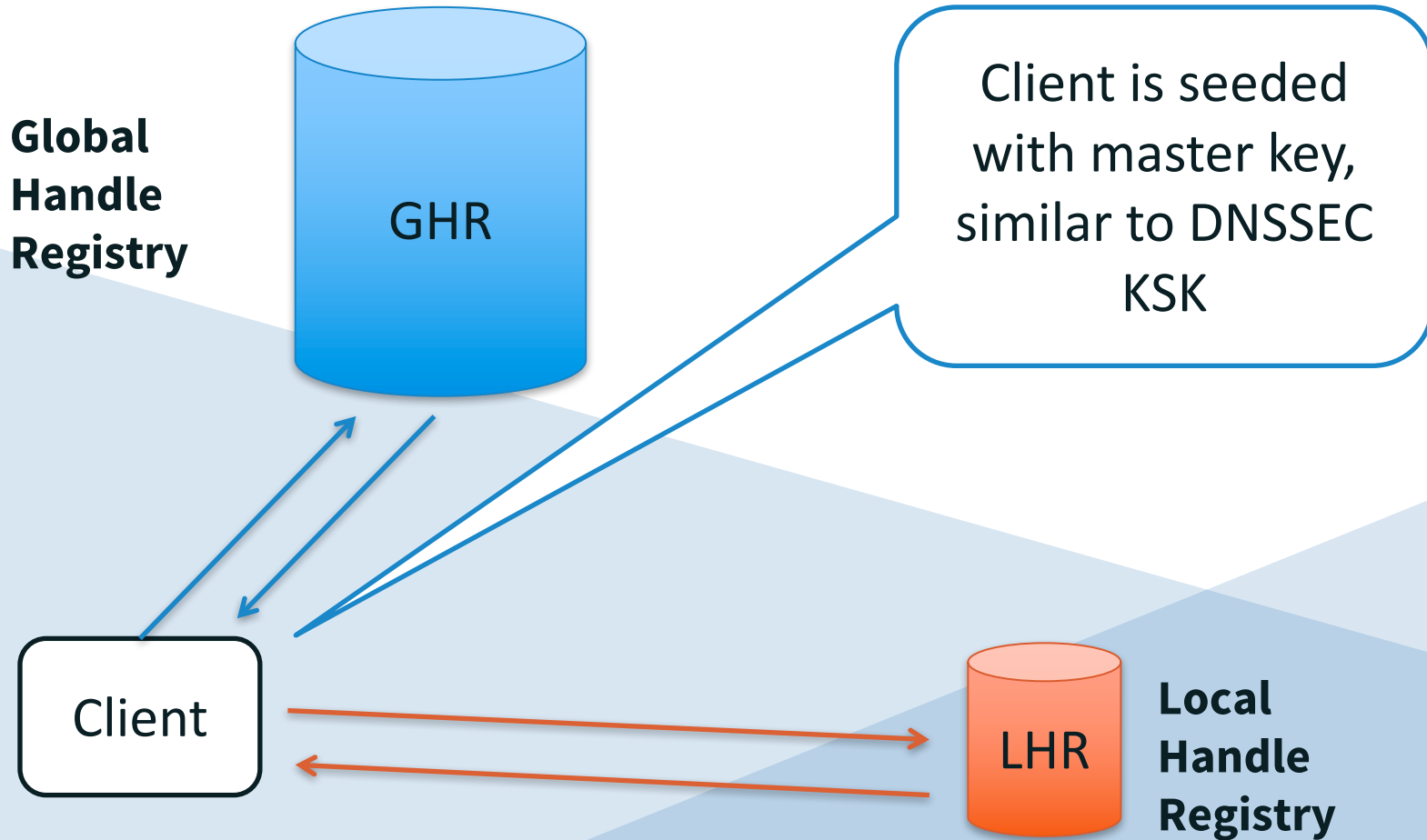
Client knows the  
hash function used  
by the handle  
registry system

# Resolution / Replication

## Global Handle Registry



# Resolution / Security



# Resolution /Proxy

Very few native DOA clients are deployed.

One example: Firefox plug-in: **hdl://11738/ithi**

Many applications use proxies: <https://hdl.handle.net/11738/ithi>

DOIs are very often seen with a URL of a proxy. For example, in 2014, the American Psychological Association (APA) changed their cross-reference syntax recommendations from:

[doi:10.1037/rmh0000008](https://doi.org/10.1037/rmh0000008)

to use the proxy form:

<http://dx.doi.org/10.1037/rmh0000008>

# Digital Objects

Local Handle Registry (**LHR**) contains a data store of objects.

A digital object is a collection of “**indexed**” **opaque structures**. Each structures can point to another handle, a URL, an email address, anything...

Example: **0.na/11738** is an object that describe the delegation of prefix 11738

## Handle.Net®

### Handle Values for: 0.na/11738

Index	Type	Timestamp	Data
100	<a href="#">HS ADMIN</a>	2015-11-20 20:00:37Z	handle=0.NA/0.NA; index=200; [create hdl,delete hdl,read val,modify val,del val,add val,modify admin]
101	<a href="#">HS ADMIN</a>	2015-11-20 20:00:37Z	handle=0.NA/11738; index=200; [create hdl,read val,list]
200	<a href="#">HS VLIST</a>	2015-11-20 20:00:37Z	300:0.NA/11738
2	<a href="#">EMAIL</a>	2015-11-20 20:00:37Z	<a href="mailto:alain.durand@icann.org">alain.durand@icann.org</a>
1	<a href="#">HS SITE</a>	2016-12-07 23:15:14Z	0001020A0002800200000000000000001000000046465736300000018416C61696E27732074657374206
300	<a href="#">HS PUBKEY</a>	2016-12-07 23:15:14Z	0000000B5253415F5055425F4B4559000000000003010001000001010088A8F4CB2EB9DBAE55FF2
400	<a href="#">HS SIGNATURE</a>	2016-12-07 23:15:14Z	eyJhbGciOiJSUzI1NiJ9.eyJkaWdlc3RzIjp7ImFsZyI6IiNIQS0yNTYiLCJkaWdlc3RzIjpbeyJpbmRlcCI6IjEWSzLoPjJX7BpzJ-7QZ59u6DFO3f4YoylPwnRgqLvwM4G0zrquAqn7-_NoDpog

# Creating Digital Objects /example

## Using the **admin portal**:

11738/ITHI

<http://hdl.handle.net/11738/ITHI> *(bypass proxy cache)*

Create new value

Save handle

Delete handle

Refresh

Sort by none

Collapse all

QR Code

Sign

Verify

> Delete Type: URL Index: 1 <http://www.icann.org/ithi>

> Delete Type: HS\_ADMIN Index: 100 handle=0.NA/11738; index=200

# More Examples

```
100 HS_ADMIN 86400 1110 ADMIN 300:11111111111111:0.NA/12345 1
    HS_SITE 86400 1110 FILE c:\somewhere\siteinfo.bin
2 HS_SERV 86400 1110 UTF8 0.NA/12345
300 HS_PUBKEY 86400 1110 FILE c:\somewhere\publickey.bin
301 HS_SECKEY 86400 1100 UTF8 my password
400 HS_VLIST 86400 1110 LIST 300:12346/USR1; 300:12347/USR2;
    7 EMAIL 86400 1110 UTF8 hdladmin@cnri.reston.va.us
8 URL 86400 1110 UTF8 http://www.handle.net
9 DESC 86400 1110 UTF8 Info about this handle
```



# Admin API

DOA servers run a JSON/REST API on port 8000. Examples:

- **GET /api/handles/{handle}**  
Get specific handle
- **PUT /api/handles/{handle}?index={index}**  
Put specific indexed handle
- **DELETE /api/handles/{handle}?index={index}**  
Delete specific indexed handle
- **GET /api/handles?prefix={prefix}**  
List handles under prefix

Requests may be authenticated by sending an “authorization” header

# Comparison of DOA and DNS

	DOA	DNS
<b>Syntax</b>	Dot-separated UFT-8 No length limitation	DNS-on-wire format DNS name format
<b>Registration</b>	MPAs	Registry/Registrar
<b>Resolution</b>	GHR LHR Replication Caching Server Hash Table	Root servers Authoritative servers Secondary servers Caching Resolvers
<b>Bits on wire</b>	HTTP/HTTPS 8000, UDP/TCP 2641	UDP/TCP port 53
<b>Data objects</b>	Extensible indexed opaque types	Defined RR types
<b>Protocol extensions</b>	DONA	IETF
<b>Governance</b>	DONA	ICANN
<b>Operation</b>	DONA/MPAs	Root/TLD/Resolver operators Registries/Registrars

# More Information

Handle System: <http://www.handle.net>

DONA foundation: <http://www.dona.net>