How it Works: Understanding RDAP

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How it Works: Understanding RDAP

Registration Data Access Protocol

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Agenda

- Introduction
- WHOIS vs. RDAP Responses
- RDAP Protocol
- gTLD RDAP Profile
- Next Steps
- Tools

Introduction

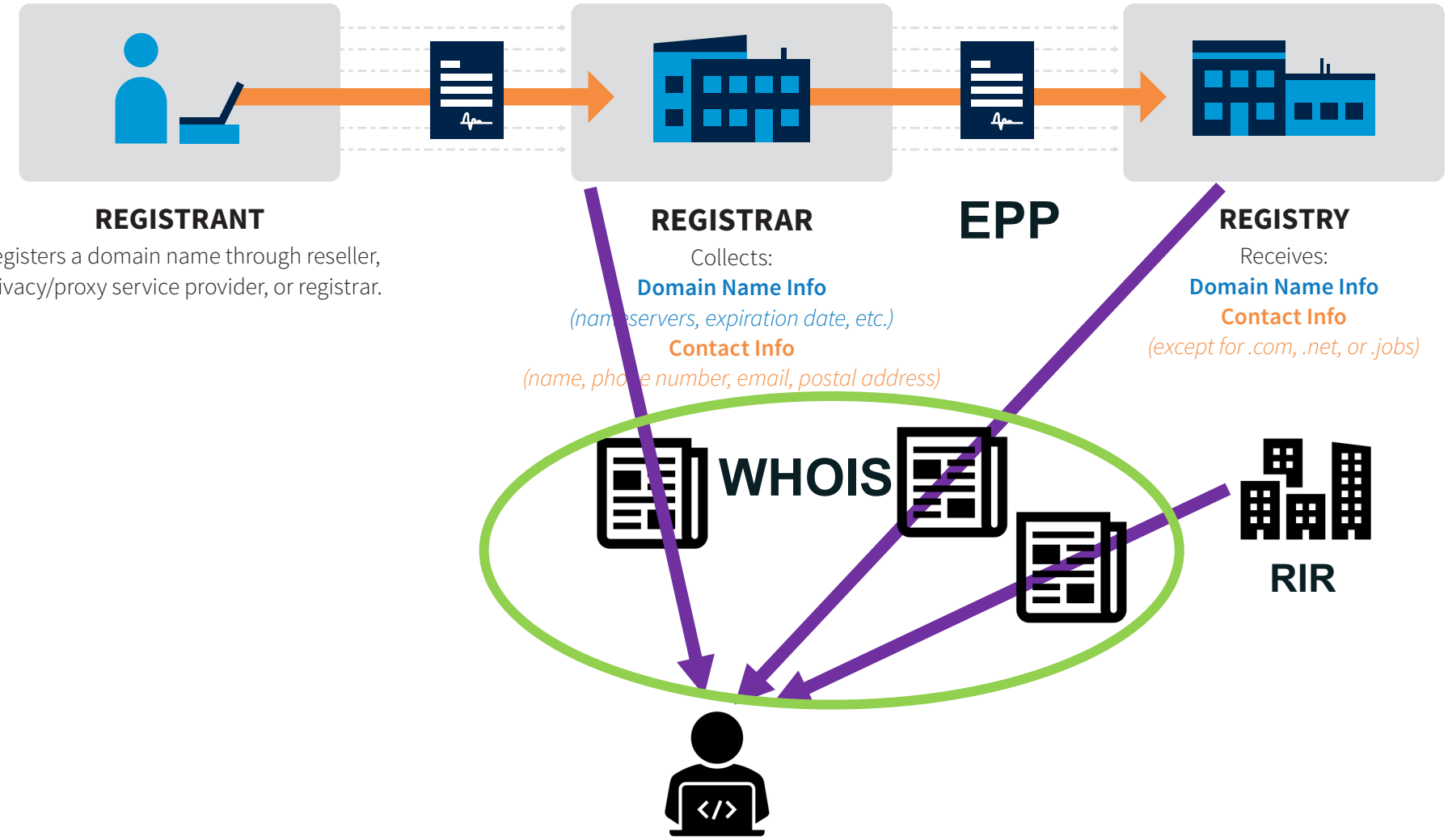
Replacing a Protocol vs. Evolving Access Rules

Two parallel lines of work in ICANN aimed at introducing:

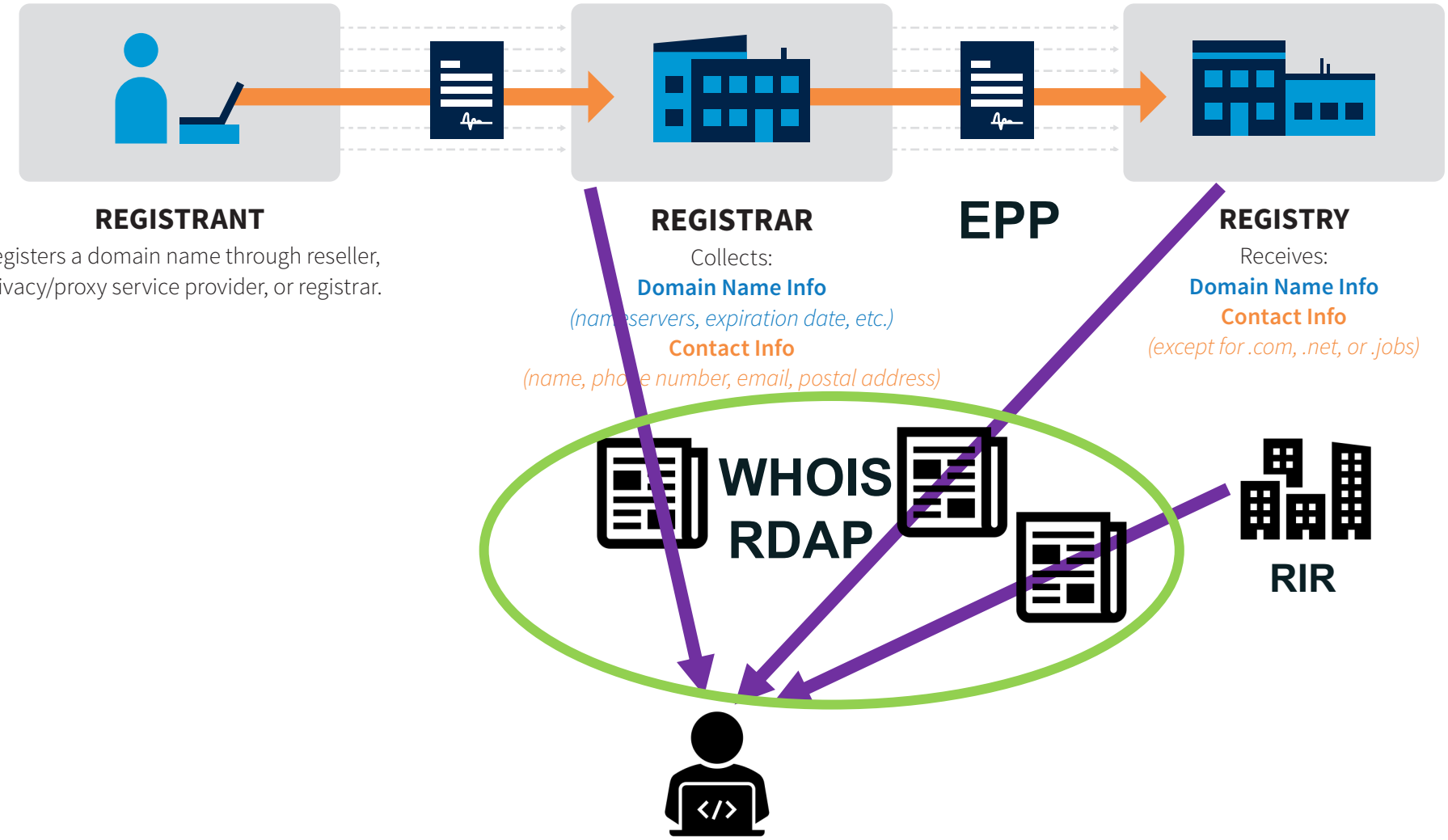
1. RDAP and eventually retiring the WHOIS protocol (triggered by user needs and technical limitations in WHOIS)

2. Policy regarding processing of registration data (e.g., collecting, transferring, displaying), and who should get access to what domain name registration data (triggered by privacy regulations)

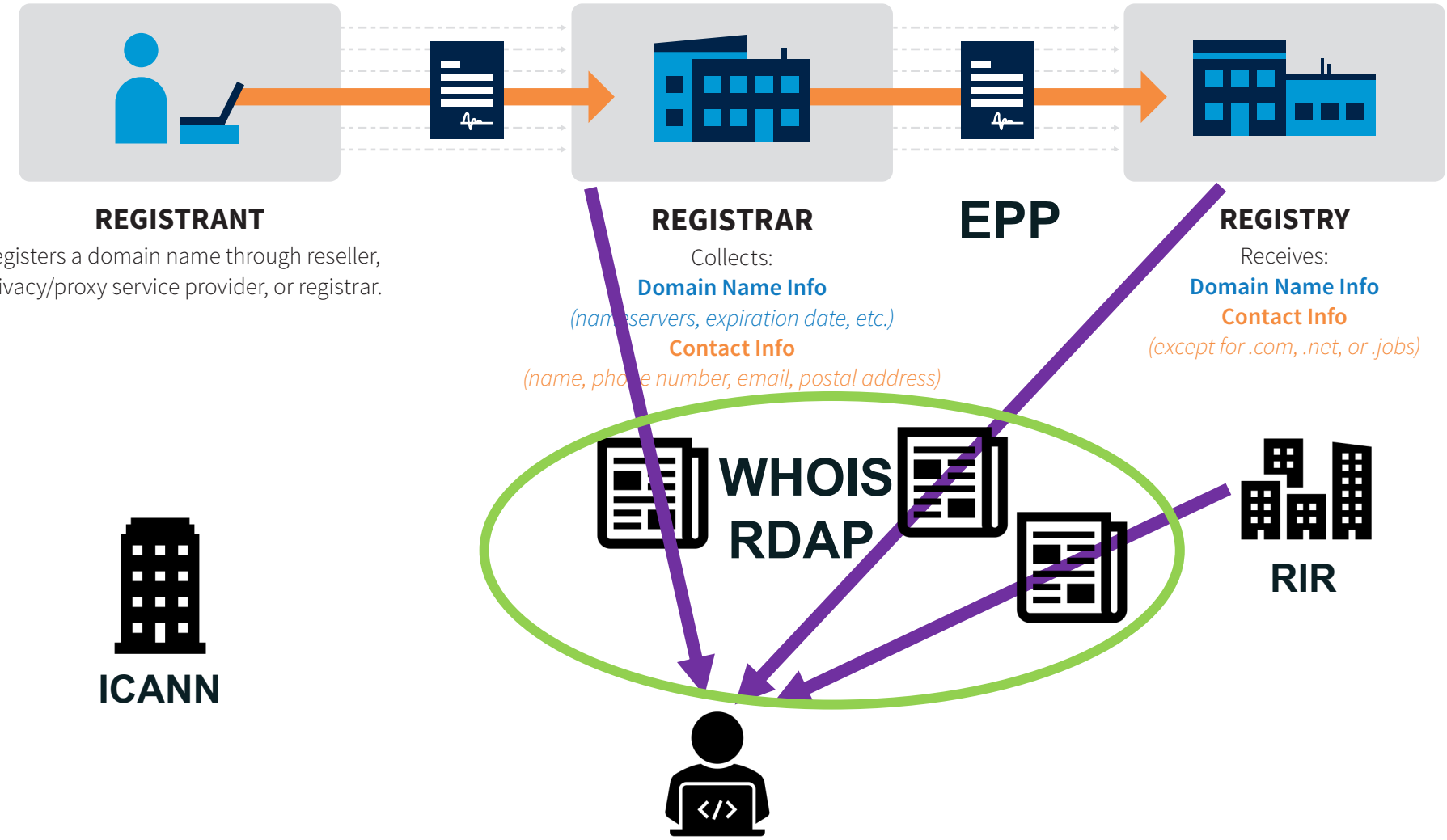
Registration Data Directory Services



Registration Data Directory Services



Registration Data Directory Services



Registration Data Access Protocol (RDAP)

- In early 2010 work began to replace WHOIS
- RIRs have been using RDAP for years now
- Some ccTLDs have been offering RDAP
- Since 26 August 2019, gTLD registries and registrars are required to implement an RDAP service
- Still more work is needed in the gTLD space to:
  - Require a common gTLD RDAP profile
  - Have an explicit, production-quality RDAP SLA
  - Have RDAP reporting requirements
  - Eventually retire WHOIS
- ICANN's RDAP page: https://icann.org/rdap

RDAP Features [1/2]

RDAP is a protocol designed in the IETF (RFCs 7480 – 7484) to replace the existing WHOIS protocol and provides the following benefits:

- Standardized query (HTTP), response (JSON) and error messages (HTTP error codes + JSON)
- Secure access to data
  - When used over HTTPS
- Extensibility
  - Easy to add query and output elements
- Enables differentiated access
  - E.g., limited access for anonymous users; full access for authenticated users

RDAP Features [2/2]

- Bootstrapping mechanism to find the authoritative server for a given query
- Standardized redirection/reference mechanism
  - From a registry to a registrar
- Builds on top of HTTP, the well-known web protocol
- Internationalization support for registration data
- Enables searches for objects
  - Domain names registered by someone, or that have given name server, etc.

Policy Developments

EPDP Phase 1

- In May 2018, the ICANN Board adopted a Temporary Specification for gTLD Registration Data
  - An interim measure to bring existing obligations in line with requirements of the European Union's General Data Protection Regulation (GDPR)
- This triggered a policy development process to confirm it, or not, as a Consensus Policy within 12 months
- The first phase of this work, known as the Expedited Policy Development Process (EPDP), published their recommendations in February 2019
- Implementation is ongoing

EPDP phase 2

- Phase 2 work started in March 2019
- Will consider a System for Standardized Access to Non-Public Registration Data
  - Expected to develop policy recommendations on who gets access, to what data, under what circumstances, etc.
- Targeting publication of initial report by December 2019, followed by final report (policy recommendations) in 2020
- Implementation would follow ICANN Board adoption of policy recommendations

EPDP Sessions in Montreal

- One EPDP phase 2 plenary session on Monday, 10:30 - 12:00
- Four EPDP phase 2 sessions
- Two Registration Data Policy (EPDP phase 1) Implementation Review Team sessions
- Please see https://66.schedule.icann.org

ICANN's TSG

- In December 2018, ICANN launched a Technical Study Group on access to non-public registration data
- The TSG explored technical solutions built on RDAP for authenticating, authorizing, and providing access to non-public registration data for third parties with legitimate interests
- In April 2019, the TSG finalized a technical model that can be considered for a Unified Access Model implementing the policy agreed by the community (e.g., EPDP phase 2)

WHOIS vs RDAP Responses

WHOIS vs. RDAP Responses

WHOIS protocol

- Plain text response
- Format varies per server

RDAP

- Text based; machine parsable
- Flexible in terms of fields and functionality
- Can be easily converted as desired

Example WHOIS Output

```
   Domain Name: ICANN.COM
   Registry Domain ID: 2346839_DOMAIN_COM-VRSN
   Registrar WHOIS Server: whois.godaddy.com
   Registrar URL: http://www.godaddy.com
   Updated Date: 2019-02-25T20:26:09Z
   Creation Date: 1998-09-14T04:00:00Z
   Registry Expiry Date: 2027-10-19T03:59:59Z
   Registrar: GoDaddy.com, LLC
   Registrar IANA ID: 146
   Registrar Abuse Contact Email: abuse@godaddy.com
   Registrar Abuse Contact Phone: 480-624-2505
   Domain Status: clientDeleteProhibited https://icann.org/epp#clientDeleteProhibited
   Domain Status: clientRenewProhibited https://icann.org/epp#clientRenewProhibited
   Domain Status: clientTransferProhibited https://icann.org/epp#clientTransferProhibited
   Domain Status: clientUpdateProhibited https://icann.org/epp#clientUpdateProhibited
   Name Server: A.IANA-SERVERS.NET
   Name Server: B.IANA-SERVERS.NET
   Name Server: C.IANA-SERVERS.NET
   Name Server: NS.ICANN.ORG
   DNSSEC: signedDelegation
   DNSSEC DS Data: 50731 8 2 6912A467DC432811BD2B1C7E5C01B20E2C60049EB57833E8308FAD0FDE779511
   URL of the ICANN Whois Inaccuracy Complaint Form: https://www.icann.org/wicf/
>>> Last update of whois database: 2019-09-25T22:55:31Z <<<
```

Example RDAP Output – unformatted

{"objectClassName":"domain","handle":"2346839_DOMAIN_COM-VRSN","ldhName":"ICANN.COM","links":[{"value":"https://rdap.verisign.com/com/v1/domain/ICANN.COM","rel":"self","href":"https://rdap.verisign.com/com/v1/domain/ICANN.COM","type":"application/rdap+json"},{"value":"https://rdap.godaddy.com/v1/domain/ICANN.COM","rel":"related","href":"https://rdap.godaddy.com/v1/domain/ICANN.COM","type":"application/rdap+json"}],"status":["client delete prohibited","client renew prohibited","client transfer prohibited","client update prohibited"],"entities":[{"objectClassName":"entity","handle":"146","roles":["registrar"],"publicIds":[{"type":"IANA Registrar ID","identifier":"146"}],"vcardArray":["vcard",[["version",{},"text","4.0"],["fn",{},"text","GoDaddy.com, LLC"]]],"entities":[{"objectClassName":"entity","roles":["abuse"],"vcardArray":["vcard",[["version",{},"text","4.0"],["tel",{"type":"voice"},"uri","tel:480-624-2505"],["email",{},"text","abuse@godaddy.com"]]]}]}],"events":[{"eventAction":"registration","eventDate":"1998-09-14T04:00:00Z"},{"eventAction":"expiration","eventDate":"2027-10-19T03:59:59Z"},{"eventAction":"last update of RDAP database","eventDate":"2019-09-25T21:59:50Z"}],"secureDNS":{"delegationSigned":true,"dsData":[{"keyTag":50731,"algorithm":8,"digestType":2,"digest":"6912A467DC432811BD2B1C7E5C01B20E2C60049EB57833E8308FAD0FDE779511"}]},"nameservers":[{"objectClassName":"nameserver","ldhName":"A.IANA-SERVERS.NET"},{"objectClassName":"nameserver","ldhName":"B.IANA-SERVERS.NET"},{"objectClassName":"nameserver","ldhName":"C.IANA-SERVERS.NET"},{"objectClassName":"nameserver","ldhName":"NS.ICANN.ORG"}],"rdapConformance":["rdap_level_0","icann_rdap_technical_implementation_guide_0","icann_rdap_response_profile_0"],"notices":[{"title":"Terms of Use","description":["Service subject to Terms of Use."],"links":[{"href":"https://www.verisign.com/domain-names/registration-data-access-protocol/terms-service/index.xhtml","type":"text/html"}]},{"title":"Status Codes","description":["For more information on domain status codes, please visit https://icann.org/epp"],"links":[{"href":"https://icann.org/epp","type":"text/html"}]},{"title":"RDDS Inaccuracy Complaint Form","description":["URL of the ICANN RDDS Inaccuracy Complaint Form: https://icann.org/wicf"],"links":[{"href":"https://icann.org/wicf","type":"text/html"}]}]}

Example RDAP Output – formatted

```
FRAR-4766:~ francisco.arias$ nicinfo --json icann.com | egrep -v "^#" | jq
{
  "objectClassName": "domain",
  "handle": "2346839_DOMAIN_COM-VRSN",
  "ldhName": "ICANN.COM",
  "links": [
    {
      "value": "https://rdap.verisign.com/com/v1/domain/ICANN.COM",
      "rel": "self",
      "href": "https://rdap.verisign.com/com/v1/domain/ICANN.COM",
      "type": "application/rdap+json"
    },
    {
      "value": "https://rdap.godaddy.com/v1/domain/ICANN.COM",
      "rel": "related",
      "href": "https://rdap.godaddy.com/v1/domain/ICANN.COM",
      "type": "application/rdap+json"
    }
  ],
  "status": [
    "client delete prohibited",
    "client renew prohibited",
    "client transfer prohibited",
    "client update prohibited"
  ],
  "entities": [
    {
      "objectClassName": "entity",
      "handle": "146",
      "roles": [
        "registrar"
      ],
      "publicIds": [
        {
          "type": "IANA Registrar ID",
          "identifier": "146"
        }
      ],
      "vcardArray": [
        "vcard",
        [
          [
            "version",
            {},
            "text",
            "4.0"
          ],
          [
            "fn",
            {},
            "text",
            "GoDaddy.com, LLC"
          ]
        ]
      ],
      "entities": [
        {
          "objectClassName": "entity",
          "roles": [
            "abuse"
          ],
          "vcardArray": [
```

```
  "events": [
    {
      "eventAction": "registration",
      "eventDate": "1998-09-14T04:00:00Z"
    },
    {
      "eventAction": "expiration",
      "eventDate": "2027-10-19T03:59:59Z"
    },
    {
      "eventAction": "last update of RDAP database",
      "eventDate": "2019-09-26T09:45:10Z"
    }
  ],
  "secureDNS": {
    "delegationSigned": true,
    "dsData": [
      {
        "keyTag": 50731,
        "algorithm": 8,
        "digestType": 2,
        "digest": "6912A467DC432811BD2B1C7E5C01B20E2C60049EB57833E8308FAD0FDE779511"
      }
    ]
  },
  "nameservers": [
    {
      "objectClassName": "nameserver",
      "ldhName": "A.IANA-SERVERS.NET"
    },
    {
      "objectClassName": "nameserver",
      "ldhName": "B.IANA-SERVERS.NET"
    },
    {
      "objectClassName": "nameserver",
      "ldhName": "C.IANA-SERVERS.NET"
    },
    {
      "objectClassName": "nameserver",
      "ldhName": "NS.ICANN.ORG"
    }
  ],
  "rdapConformance": [
    "rdap_level_0",
    "icann_rdap_technical_implementation_guide_0",
    "icann_rdap_response_profile_0"
  ],
  "notices": [
    {
      "title": "Terms of Use",
      "description": [
        "Service subject to Terms of Use."
      ],
      "links": [
        {
          "href": "https://www.verisign.com/domain-names/registration-data-access-protocol/terms-service/index.xhtml",
          "type": "text/html"
        }
      ]
    },
    {
      "title": "Status Codes",
```

RDAP Web Client

Enter a domain name

Frequently Asked Questions (FAQ)

icann.com

Lookup

By submitting any personal data, I acknowledge and agree that the personal data submitted by me will be processed in accordance with the ICANN Privacy Policy, and agree to abide by the website Terms of Service and the Domain Name Registration Data Lookup Terms of Use.

Domain Information

Name: ICANN.COM

Registry Domain ID: 2346839_DOMAIN_COM-VRSN

Domain Status:

Nameservers:
NS.ICANN.ORG
A.IANA-SERVERS.NET
B.IANA-SERVERS.NET
C.IANA-SERVERS.NET

Dates

Registry Expiration: 2027-10-19 03:59:59 UTC

Registrar Expiration: 2027-10-18 22:59:59 UTC

Created: 1998-09-14 04:00:00 UTC

Contact Information

RDAP Protocol

RDAP RFCs

- RFC 7480 – HTTP Usage in RDAP
- RFC 7481 – Security Services for RDAP
- RFC 7482 – RDAP Query Format
- RFC 7483 – JSON Responses for RDAP
- RFC 7484 – Finding the Authoritative Registration Data RDAP Service
- RFC 8056 – EPP and RDAP Status Mapping
- RFC 8521 – RDAP Object Tagging
- RFC 8605 – vCard Format Extensions: ICANN Extensions for RDAP

Internet Engineering Task Force (IETF)

- *The mission of the IETF is to produce high quality, relevant technical and engineering documents that influence the way people design, use, and manage the Internet in such a way as to make the Internet work better.*
- *Any interested person can participate in the work, know what is being decided, and make his or her voice heard on the issue.*
- *The IETF make standards based on the combined engineering judgement of our participants and our real-world experience in implementing and deploying our specifications*

IETF's REGEXT Working Group

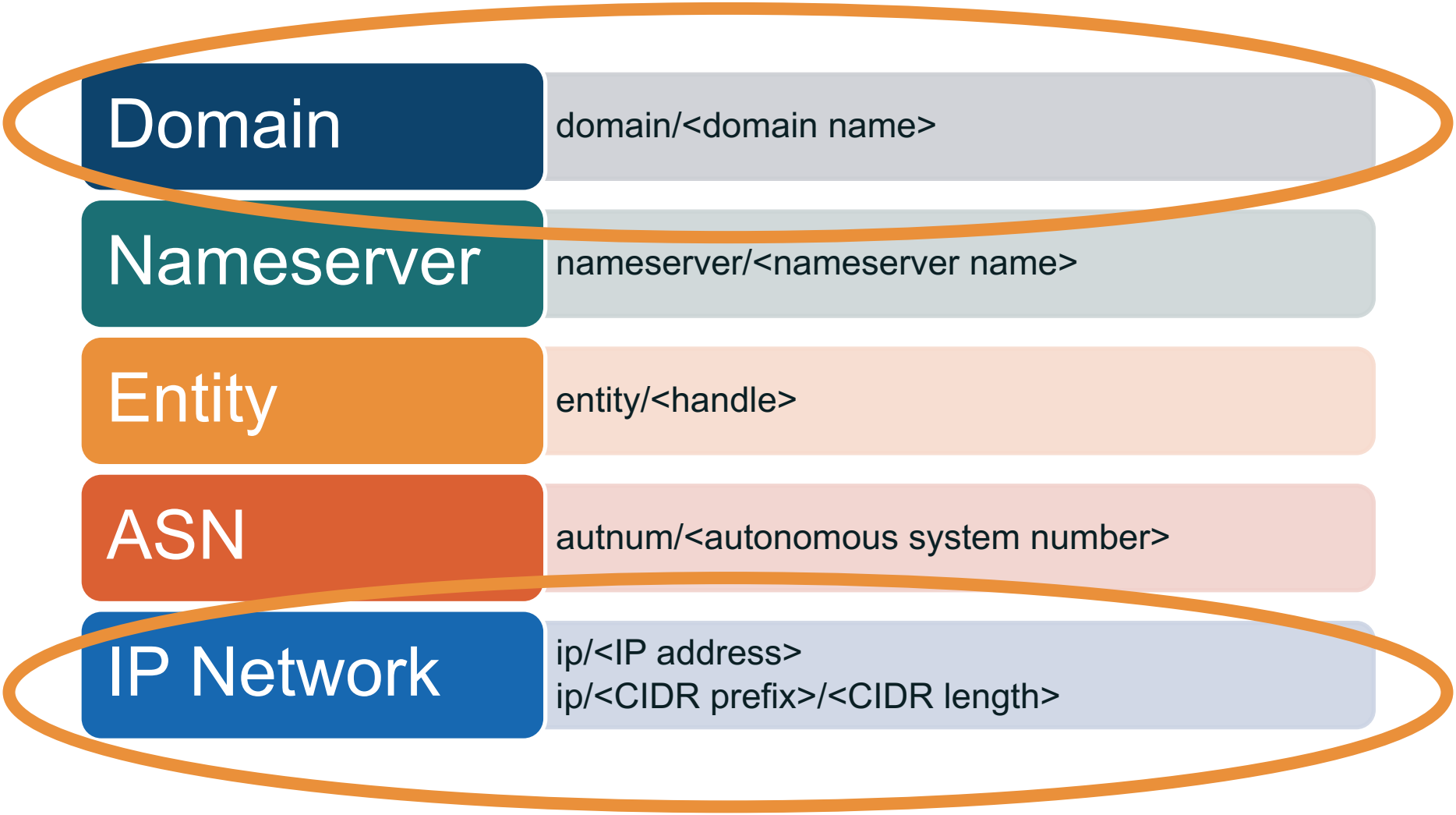
- The technical work of the IETF is done in working groups, which are organized by topic
- The REGEXT WG is the RDAP protocol is maintained and extended
- RIRs, registries and registrars participate in the REGEXT WG

Lookup vs. Search

- Lookup is a query for a specific object, e.g., a query for the domain name ”icann.org”

- Search is a query for objects with shared characteristics, e.g., domain names registered by the organization “ACME Inc”, or the registrant “John Smith”, or that contain the word “acme”, etc.

RDAP Lookup URL Specification



Domain Queries

Domain query <baseUrl>/domain/<domain name>

- Used to identify a domain name and associated data referenced.
- The <domain name> is a fully qualified domain name.
  - A-label and U-label format are both supported
- Examples:
  - https://rdap.nic.example/domain/foo.example
  - https://rdap.nic.example/domain/网站.域名
  - https://rdap.nic.example/domain/xn--fo-5ja.example

JSON – JavaScript Object Notation

- RDAP responses are provided using JSON (RFC 7159)
- JSON objects are unordered sets of name/value pairs
  - E.g. { “name” : “value” }
- JSON defines the following data types for the values:
  - Number
  - String
  - Boolean (true or false)
  - Array
  - Object
  - Null

Example

```
{
  "title"     : "Introduction to JSON",
  "isbn".     : "123456-ABC",
  "author"    : "John Doe",
  "pages"     : 80,
  "published" : true,
  "tableOfContents" :
  [
    { "section" : "Introduction", "page" : 2  },
    { "section" : "Chapter 1",    "page" : 8  },
    { "section" : "Chapter 2",    "page" : 31 },
    { "section" : "Epilogue",     "page" : 57 },
    { "section" : "Appendix A",   "page" : 70 }
  ]
}
```

Domain Response

Member	Type	Description
handle	String	The unique identifier of the domain object response
ldhName	String	The domain name in LDH form
unicodeName	String	The domain with U-labels
variants	Object array	An array of objects, each with the following values: • relation • idnTable • variantNames
nameservers	Object array	Name
entities	Object array	Entity objects related to this domain object
network	Object array	The IP network for which a revers DNS domain is referenced

Domain Response

Member	Type	Description

secureDNS	Object	DNSSEC related info with the following members:
		• zoneSigned
		• delegationsigned
		• maxSigLife
		• dsData
		  • flags
		  • keyTag
		  • algorithm
		  • digest
		  • digestType
		  • events
		  • links
		• keyData
		  • flags
		  • protocol
		  • publicKey
		  • algorithm
		  • events
		  • links

Entity Response

Member	Type	Description
handle	String	The unique identifier of the entity
vcardArray	Object	A jCard (RFC 7095) with the entity's contact information
roles	String array	The relationship an object would have with it's closes containing object. • Role values defined in the IANA registry for RFC 7483
entities	Object array	Entity objects related to this entity object
asEventActor	Object array	Same as the "events" common data structure, denoting this entity as the event actor for the given events.
networks	Object array	ipNetwork objects related to this entity
autnums	Object array	autnum objects related to this entity

Entity Response – jcard Example

Jcard Properties

- version
- **fn**
- kind
- lang
- **org**
- title
- role
- **adr**
- **tel**
- **email**
- lang
- geo
- gender
- …

"adr" Member Order

1. Post office box
2. Extended address
3. Street address
4. Locality (e.g. city)
5. Region (e.g. state or province)
6. Postal code
7. Country name

```
"vcardArray": [
  "vcard", [
     [ "version", {}, "text", "4.0" ],
     [ "fn", {}, "text", "John Doe" ],
     [ "org", {}, "text", "ICANN" ],
     [ "tel", {}, "uri", "tel:+1-123-456-7890" ],
     [ "adr", {}, "text", [
                "",
                "",
                "6 Rond-Point Schuman",
                "Brussels",
                "",
                "B-1040",
                "Belgium"
                ]
     ]
  ]
]
```

Nameserver Queries

Nameserver query	<baseUrl>/nameserver/<nameserver name>

- Used to identify a nameserver information query using a host name.
- The <nameserver name> is a fully qualified host name.
  - A-label and U-label format are both supported
  - Some examples:
    - ns1.example.com
    - ns1.xn--fo-5ja.example
    - ns1.网站.域名

Nameserver Response

Member	Type	Description
handle	String	The unique identifier of the nameserver object response
ldhName	String	The nameserver in LDH form
unicodeName	String	The DNS Unicode name of the nameserver
ipAddresses	Object array	An object array with the following members: • v6: as an array of strings with IPv6 addresses of the nameserver • v4: as an array of strings with IPv4 addresses of the nameserver
entities	Object array	Entity objects related to this nameserver object

IP Network Queries

IP Network query

<baseUrl>/ip/<IP address>
<baseUrl>/ip/<CIDR prefix>/<CIDR length>

- Used to identify IP networks and associated data referenced using either an IPv4 or IPv6 address.
- Query targets the smallest IP network that encompasses the provided address in a hierarchy of IP networks
- The <IP address> may be IPv4 dotted decimal or IPv6 address (RFC 4291)
  - IPv6 recommended text representation per RFC 5952.
  - IPv6 zone_id not supported and must not be used (RFC 6874)
- CIDR notation address blocks prefix and length are defined in RFC 4632
- Some examples
  - 192.0.2.0
  - 192.0.2.0/24
  - 2001:db8::0

IP Network Response

Member	Type	Description
handle	String	The RIR-unique identifier of the network registration
startAddress	String	Starting v4 or v6 IP address of the network
endAddress	String	Ending v4 or v6 IP address of the network
ipVersion	String	the IP protocol version ("v4" or "v6")
name	String	identifier assigned to the network registration by the registration holder
type	String	RIR-specific classification of the network
country	String	2-character country code of the network
parentHandle	String	RIR-unique identifier of the parent network of this registration
entities	Object array	Entity objects related to this network

Autonomous System Number Queries

ASN query <baseUrl>/autnum/<autonomous system number>

- Used to identify Autonomous System number registrations and associated data referenced
- The <autonomous system number> is an autonomous system number
  - Format as specified in RFC 5396
  - Target of the query is the ASN block registration that includes the queried number

Autonomous System Number Response

Member	Type	Description
handle	String	RIR-unique identifier of the ASN registration
startAutnum	Number	A number representing the starting number in the block of ASNs
endAutnum	Number	A number representing the ending number in the block of ASNs
name	String	Identifier assigned to the ASN registration by the registration holder
type	String	RIR-specific classification of the ASN
country	String	The 2-character country code of the ASN
entities	Object array	Entity objects related to this ASN

Error responses

- **Error responses** have a basic structure that allows the response to include information describing the error.
  - *errorCode* value is based on the HTTP response code

```
{
   "errorCode": 400,
   "title": "Incorrect path segment",
   "description":
   [
      "Error processing this request.",
      "Please try again."
   ]
}
```

Internationalization in RDAP

- Internationalized domain names are supported in both the query and the response
- Internationalized contact information is also supported
- Contact information supports language tags in order to identify the language/script of data fields
- Replies are JSON formatted, which supports and by default requires UTF-8
- UTF-8 is a Unicode encoding. Unicode supports most of the world's writing systems.

Bootstrapping

- RDAP includes a standard mechanism that allows a client to find the authoritative server for a domain name, IP address, etc.
- RDAP specification explains how to form direct queries and basic search queries
- IANA maintains a list of the “base RDAP URLs” at:
  - https://data.iana.org/rdap/
  - Base URL example: https://rdap.nic.example/

Extensibility in RDAP

- RDAP was defined with extensibility in mind
- An RDAP extension augments the features of the RDAP protocol
  - https://www.iana.org/assignments/rdap-extensions/rdap-extensions.xhtml
- Several IANA Registries are used to easily extend the values defined in RDAP
  - Adds value to the RDAP related IANA Registries
  - Lightweight process that involves sending an email to IANA. Next an expert does a quick review and approves or rejects the addition

Current Proposed RDAP Extensions

- RDAP Reverse Search Capabilities (draft-ietf-regext-rdap-reverse-search)
- RDAP Partial Response (draft-ietf-regext-rdap-partial-response)
- RDAP Query Parameters for Result Sorting and Paging (draft-ietf-regext-rdap-sorting-and-paging)
- Federated Authentication for the RDAP using OpenID Connect (draft-ietf-regext-rdap-openid)

gTLD RDAP Profile

RDAP Responses in the gTLD Space

gTLD RDAP Profile

- RDAP is a flexible protocol that allows implementers to choose from different features
- The gTLD RDAP Profile defines the features to be supported by gTLD registries and registrars implementing an RDAP service
- The profile intends to map current policy requirements to the RDAP implementation

gTLD RDAP Profile

- A discussion group of gTLD registries and registrars developed a gTLD-RDAP Profile consisting of two documents:

  1) RDAP Technical Implementation Guide

  2) RDAP Response Profile

- For now, compliance with the profile is recommended but not required from gTLD registries and registrars

What is Prescribed by the Profile

- What fields are to be included in a response
  - Adding fields without further approval from ICANN
- Object queries to be supported (e.g., domains, name servers, contacts, registrars)
- Supporting both IPv4 and IPv6 transport
- HTTP headers enabling web clients (like ICANN's)
- DNSSEC
- Rejecting queries for IDNs mixing A- and U-labels

What is Prescribed by the Profile

- Registrars providing to ICANN their base RDAP URLs
- Inclusion of “Terms of Service”
- Support for “Help” queries
- Truncated responses having to indicate reason
- Use of country code instead of country name
- URI to facilitate communication with a contact
- URL for AWIP compliance

What is Prescribed by the Profile

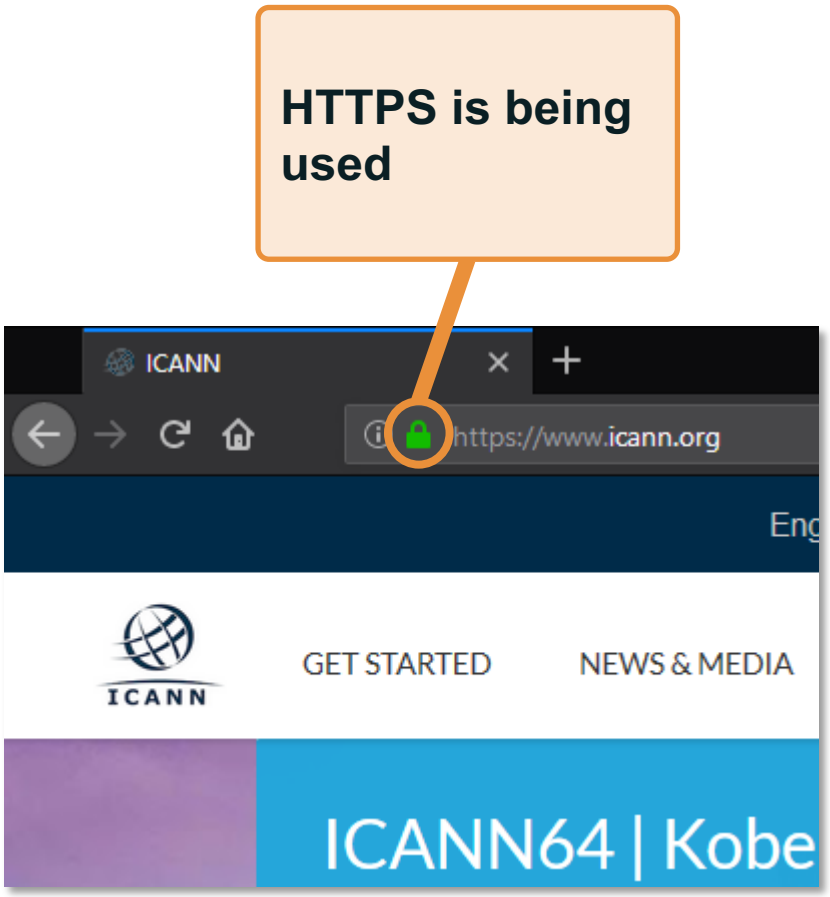
- Requirement to register RDAP extensions with IANA
- Inclusion of DNSSEC elements
- Registrars only responding for their sponsored names
- Using registrar identifier for contacts in thin registries
- Allows for unredacted responses on the basis of a legitimate interests pursued by third party (Temp spec)

References from Registry to Registrar

- A registry provides in the RDAP response a URL to the registrar's RDAP service that allows obtaining authoritative information maintained by the Registrar
  - In today's thin registry environments (e.g., .com, and .net), the registry does not collect domain contact data
  - The URL provided by the registry allows the user to obtain the (contact data) that is only available in the registrar

Data Confidentiality and Integrity

- Hypertext Transfer Protocol Secure (HTTPS) is the security protocol of choice on the Internet.
- HTTPS create an encrypted channel between the client and service provider.
- HTTPS uses Transport Layer Security (TLS) as the basis for providing the security services.



Redaction Requirements

- When applicable per policy, fields to be redacted are **not** to be included in the response
- A remarks element is to be included within the redacted contact, including:
  - a **specific** type ("*object redacted due to authorization*")
  - a **specific** description ("*Some of the data in this object has been removed*")
  - a title **substantially similar** to ("*REDACTED FOR PRIVACY*")

Differentiated Access

- Differentiated access refers to showing different subsets of data fields based on the permissions of who is asking
- The Temporary Specification for gTLD Registration Data defines a minimum output and also requires providing access to further data on the basis of legitimate interest
- Further policy work/requirements have to be developed in order to have a Unified Access Model that would provide for this access in a consistent way in gTLDs

RDAP Adoption – Next Steps

ICANN is working with gTLD registries and registrars to:

- Adopt a gTLD-RDAP service-level agreement (SLA)
- Adopt reporting requirements for registries (e.g., how many RDAP queries were received in a month)
- Require adherence to a common gTLD RDAP profile
- Retire WHOIS

RDAP Tools

RDAP Client Implementations Available

- ICANN's RDAP web client
- CentralNIC
- DNSBelgium
- NicInfo
- OpenRDAP

Demonstration

- ICANN org's web client
  - For now, only supports domain object lookups

- Command line RDAP client

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