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getdns Unbound security API is:

- A *DNS API* specification (for resolving)
  by and for application developers (for applications)
- First implementation by VERISIGN LABS and NLnet Labs

From Verisign:

Allison Mankin, Glen Wiley, Neel Goyal, Angelique Finan, Craig Despeaux, Shumon Huque, Duane Wessels, Gowri Visweswaran

From NLnet Labs:

Willem Toorop, Wouter Wijngaards, Olaf Kolkman

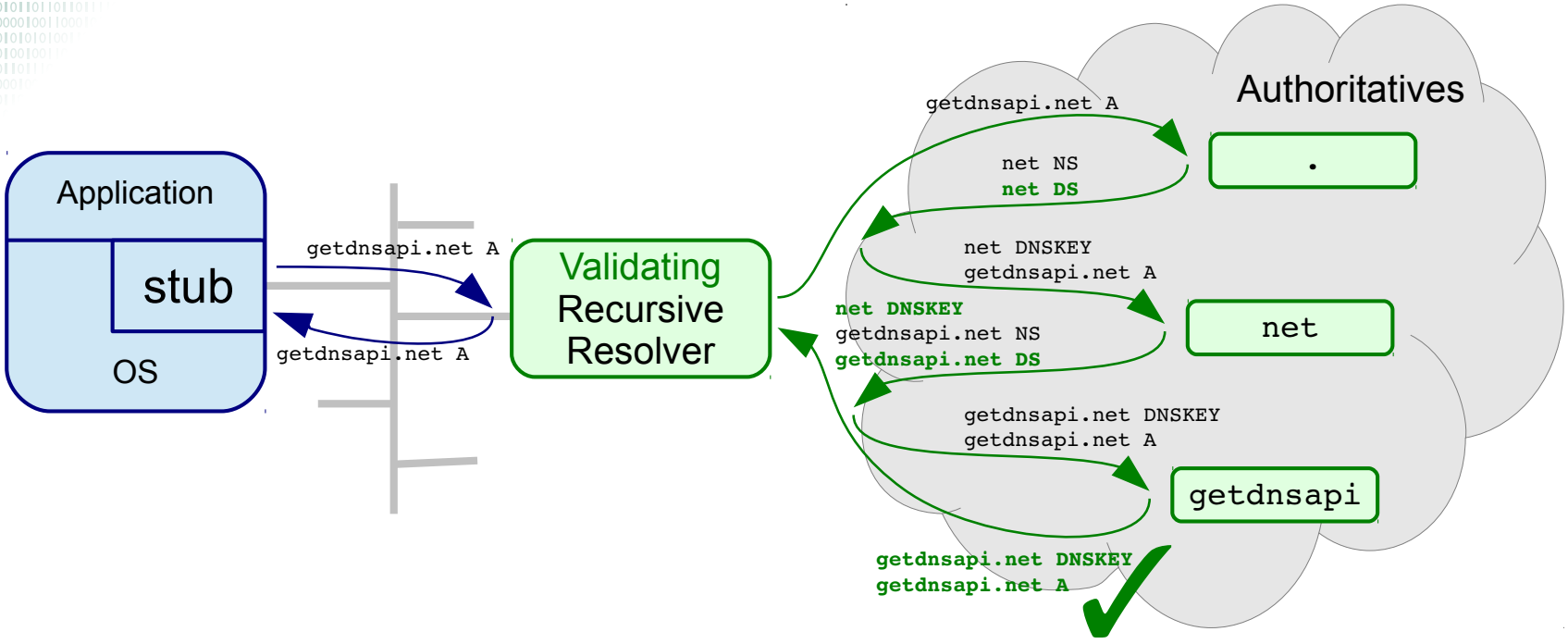
From No Mountain Software:

Melinda Shore

From Sinodun:

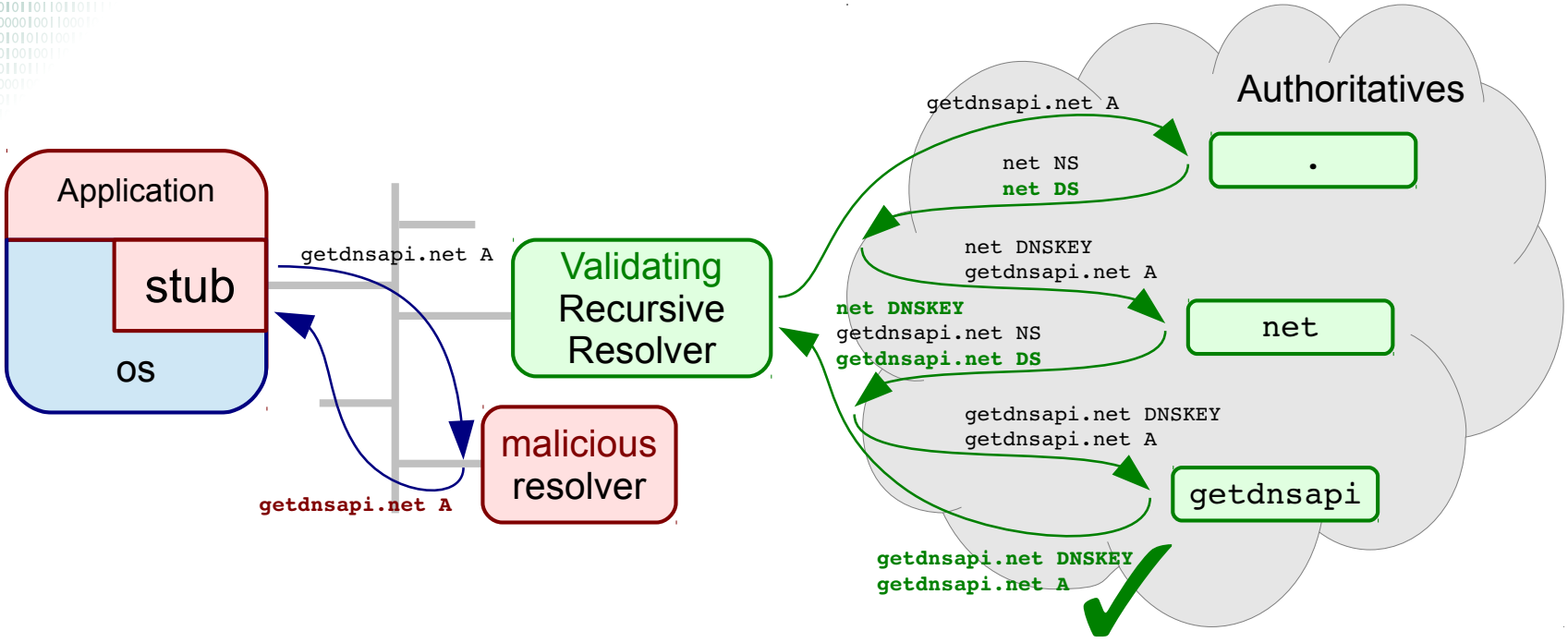
John & Sara Dickinson

Motivation - DNSSEC - The Last Mile



- A DNSSEC enabled resolver protects against cache poisoning
- Application does not know an answer is secure
  (AD bit not given with `getaddrinfo()`)

Motivation - DNSSEC - The Last Mile



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- Is the local network resolver trustworthy?

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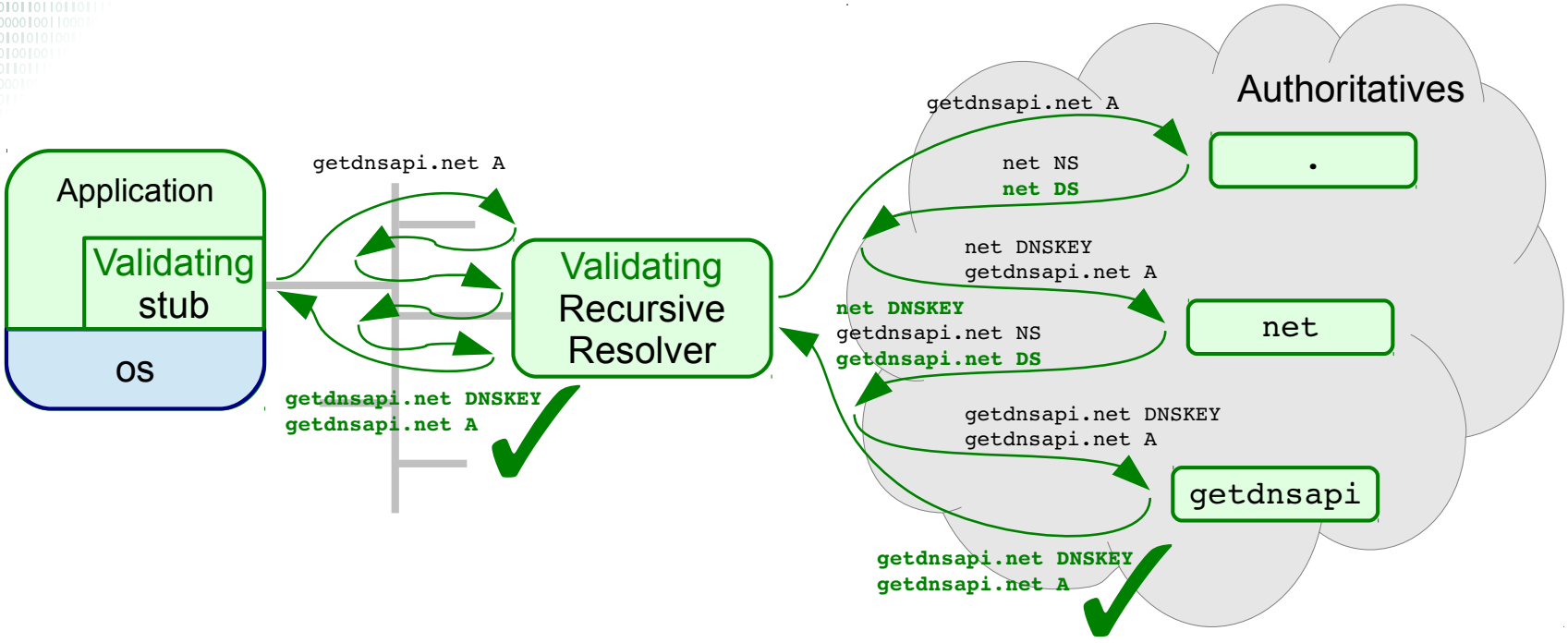

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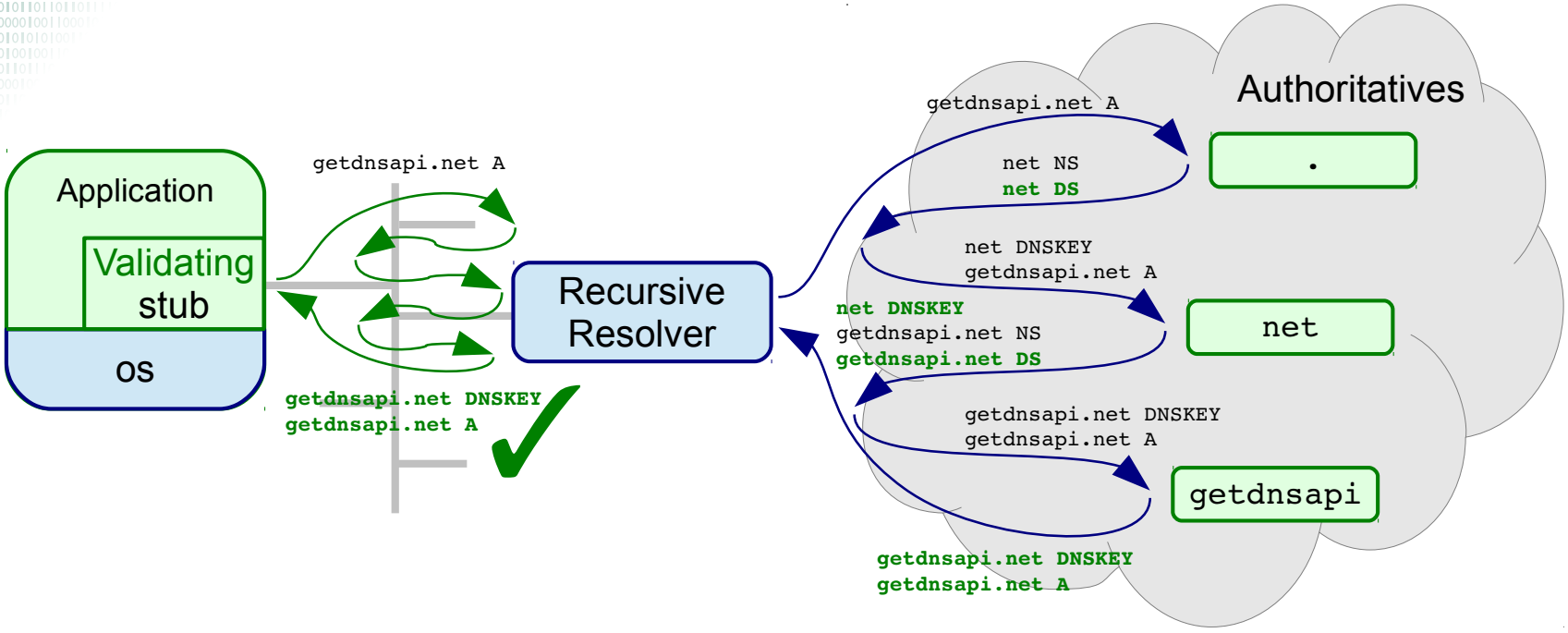
Motivation - DNSSEC - The Last Mile

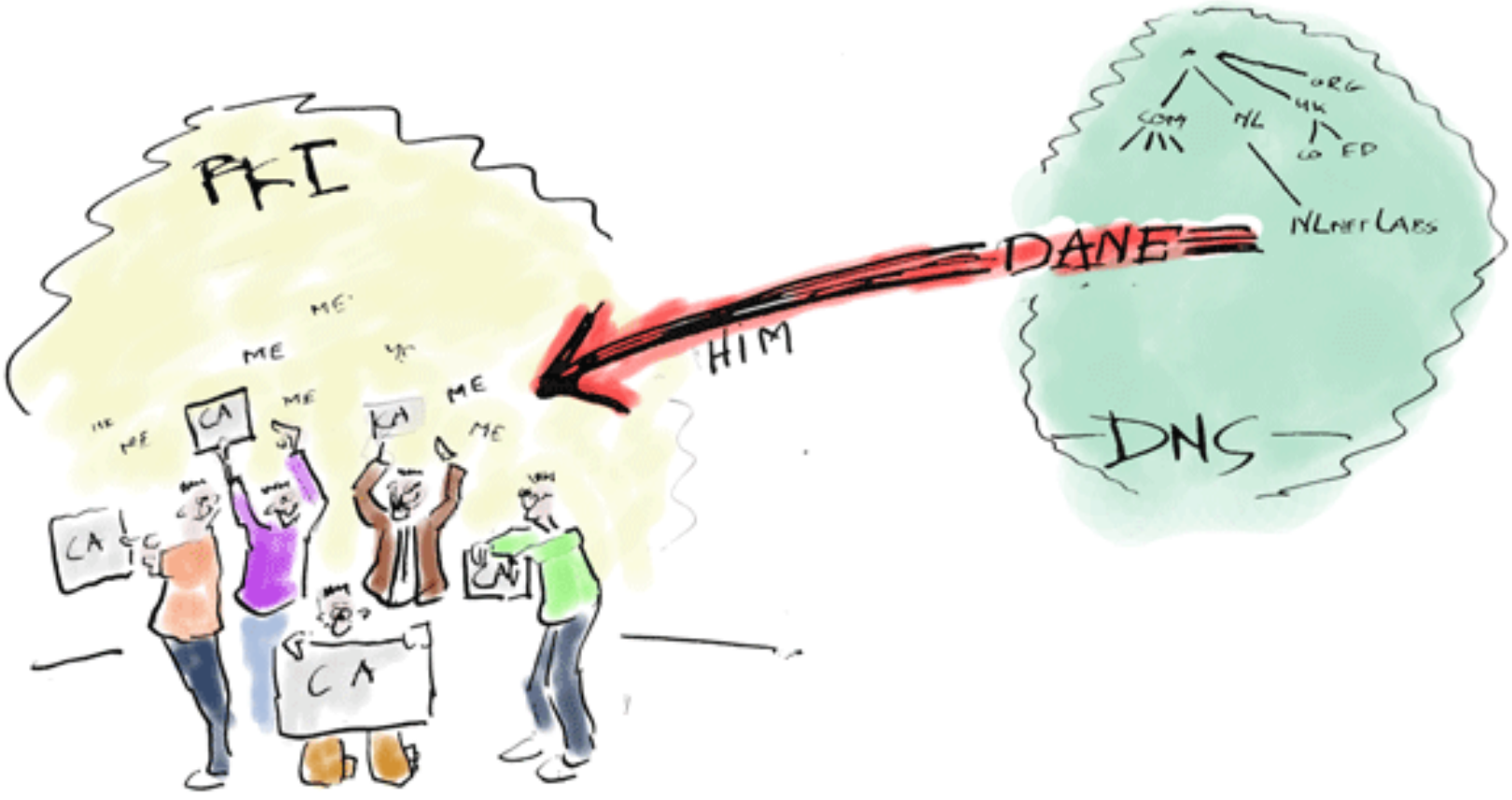


- A DNSSEC enabled resolver protects against cache poisoning
- Application does not know an answer is secure
- Is the local network resolver trustworthy?
- Is the local network resolver validating?

(90% of RIPE ATLAS probes have a DNSSEC-aware resolver
Presentation next Wednesday at the DNS-WG of RIPE68)

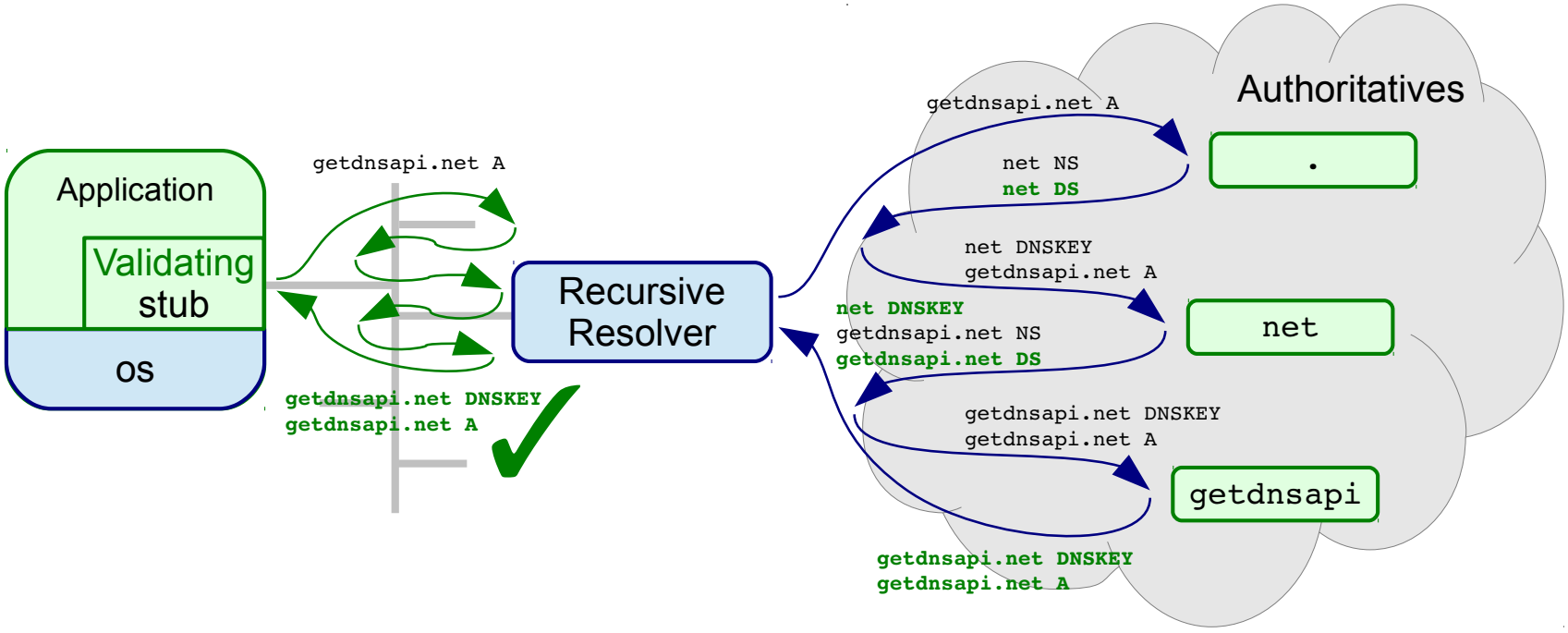
Motivation - DNSSEC - DANE

- A DNSSEC enabled resolver protects against cache poisoning
- By delivering origin authentication
- Enabling **D**NS-based **A**uthentication of **N**amed **E**ntities



Motivation - DNSSEC - DANE

- A DNSSEC enabled resolver protects against cache poisoning
- By delivering origin authentication
- Enabling **D**NS-based **A**uthentication of **N**amed **E**ntities



Entities to be used in applications ... a perfect match ...

Motivation - Other DNS data

not accessible with `getaddrinfo()` & `getaddrinfo()`

- `TXT` lookups for e-mail

  Sender Policy Framework (SPF), Domain Keys Identified Mail (DKIM), Domain-based Message Authentication, Reporting and Conformance (DMARC)

- `SRV` lookups for applications using services (jabber, sip etc.)
- DANE lookups
  - `TLSA` for setting up TLS connections
  - `SMIMECERT` and `OPENPGPKEY` for validating signed e-mail *and to lookup keys for encrypting messages*
  - more will follow...

Motivation - for a new DNS API

From API Design considerations:

... There are other DNS APIs available, but there has been very little uptake ...

... talking to application developers ... the APIs were developed by and for DNS people, not application developers ...

Motivation - for a new DNS API

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... There are other DNS APIs available, but there has been very little uptake ...

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Goal

... API design from talking to application developers ...

... create a natural follow-on to `gettadrinfo()` *...*

Motivation - for a new DNS API

Goal

... API design from talking to application developers ...

... create a natural follow-on to `gettadrinfo()` *...*

- `http://www.vpnc.org/getdns-api/`
- Edited by Paul Hoffman
- First publication April 2013
- Updated in February 2014
  (after extensive discussion during implementation)

- Creative Commons Attribution 3.0 Unported License

Motivation - for our implementation

From the README:

... DNSSEC offers a unique global infrastructure for establishing cryptographic trust relations ...

... offer application developers a modern and flexible way that enables end-to-end trust in the DNS architecture ...

... inspire application developers towards innovative security solutions ...

- `http://getdnsapi.net/`
- Collaborative effort of Verisign Labs & NLnet Labs
- 0.1.0 release in February 2014, 0.1.1 in March
- nodejs and python bindings
- Hack battle at The Next Web in Amsterdam in April 2014
- BSD 3-Clause License

Implementation - Features

- Resolves names and gives fine-grained access to the response
- Both stub and full recursive modes (recusive by default)
- Asynchronous modus operandi is the default
- Response dict type
  - Easy to inspect: `getdns_pretty_print_dict()`
  - Maps well to popular modern scripting languages
- Delivers validated DNSSEC even in stub mode (off by default :( )
  - Given that the recursive resolver is DNSSEC-aware
  - 90% of RIPE ATLAS probes have a DNSSEC-aware resolver
    Presentation next Wednesday at the DNS-WG of RIPE68
- Modular event base: libevent, libev, libuv
  ... or just use file descriptor

Implementation - Building / Dependencies

We try to minimize dependencies

libunbound For resolving

(Currently both recursive and stub)

libldns For parsing and constructing wire-format DNS data

(Will do the stub resolving in future releases)

libidn1 Only `getdns_convert_ulabel_to_alabel()` and `getdns_convert_alabel_to_ulabel()`

Pluggable event library extensions

One or more of: libevent 1, libevent 2, libuv, libev

- Build dependency: doxygen
- Install dependency: unbound-anchor

Implementation - Supported platforms

We support

- Debian 7.0, 7.3
- FreeBSD 8.4, 9.2, 10.0
- RHEL/CentOS 6.4, 6.5
- OSX 10.8, 10.9
- Ubuntu 12.04, 13.10

We provide binary packages for

- CentOS/RHEL 6.5
- MacOS X

Packages are available for

FreeBSD Via ports

MacOS X Via homebrew

Packages in the make

Debian Ondřej Surý

Fedora Paul Wouters

MS-Windows and Android in the future

Hands on getdns - Async DNS lookups

```
getdns_return_t getdns_general(
    getdns_context          *context,
    const char              *name,
    uint16_t                 request_type,
    getdns_dict             *extensions,
    void                    *userarg,
    getdns_transaction_t    *transaction_id,
    getdns_callback_t        callbackfn
);
```

- `context` contains configuration parameters

  (Stub or recursive modus operandi, timeout values, root-hints, forwarders, trust anchor, search path (+ how to evaluate (not implemented yet)) etc.)

- `context` contains the resolver cache

Hands on getdns - Async DNS lookups

```
getdns_return_t getdns_general(
    getdns_context          *context,
    const char              *name,
    uint16_t                 request_type,
    getdns_dict             *extensions,
    void                    *userarg,
    getdns_transaction_t    *transaction_id,
    getdns_callback_t        callbackfn
);
```

- `context` contains configuration parameters and resolver cache
- `name` and `request_type` the name and type to lookup

Hands on getdns - Async DNS lookups

```
getdns_return_t getdns_general(
    getdns_context          *context,
    const char              *name,
    uint16_t                 request_type,
    getdns_dict             *extensions,
    void                    *userarg,
    getdns_transaction_t    *transaction_id,
    getdns_callback_t        callbackfn
);
```

- `context` contains configuration parameters and resolver cache
- `name` and `request_type` the name and type to lookup
- `extensions` additional parameters specific for this lookup
  - `return_both_v4_and_v6`
  - `dnssec_return_status`
  - `specify_class` (not implemented yet)
  - `add_opt_parameter` (not implemented yet)

Hands on getdns - Async DNS lookups

```
getdns_return_t getdns_general(
    getdns_context          *context,
    const char              *name,
    uint16_t                 request_type,
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    void                    *userarg,
    getdns_transaction_t    *transaction_id,
    getdns_callback_t        callbackfn
);
```

- `context` contains configuration parameters and resolver cache
- `name` and `request_type` the name and type to lookup
- `extensions` additional parameters specific for this lookup
- `userarg` is passed in on the call to `callbackfn`
- `transaction_id` is set to a unique value that is also passed in on the call to `callbackfn`

Hands on getdns - Async DNS lookups

```
getdns_return_t getdns_general(
    getdns_context          *context,
    const char              *name,
    uint16_t                 request_type,
    getdns_dict             *extensions,
    void                    *userarg,
    getdns_transaction_t    *transaction_id,
    getdns_callback_t        callbackfn
);

typedef void (*getdns_callback_t)(
    getdns_context          *context,
    getdns_callback_type_t   callback_type,
    getdns_dict             *response,
    void                    *userarg,
    getdns_transaction_t     transaction_id
);
/* callback_type = complete, cancel, timeout or error */
```

Hands on getdns - Synchronous lookups

```
getdns_return_t getdns_general(
    getdns_context          *context,
    const char              *name,
    uint16_t                 request_type,
    getdns_dict             *extensions,
    void                    *userarg,
    getdns_transaction_t    *transaction_id,
    getdns_callback_t        callbackfn
);

getdns_return_t getdns_general_sync(
    getdns_context        *context,
    const char            *name,
    uint16_t               request_type,
    getdns_dict           *extensions,
    getdns_dict          **response
);
```

Hands on getdns - Address lookups

```
getdns_return_t getdns_address(
    getdns_context          *context,
    const char              *name,
    getdns_dict             *extensions,
    void                    *userarg,
    getdns_transaction_t    *transaction_id,
    getdns_callback_t        callbackfn
);
```

- Also lookups in other name systems
  (local files, WINS, mDNS, NIS) (not implemented yet)
- With the Domain Name Space returns both IPv4 and IPv6
  (i.e. the `return_both_v4_and_v6` extension is set)

Hands on getdns - Reverse lookups

```
getdns_return_t getdns_hostname(
    getdns_context          *context,
    getdns_dict             *address,
    getdns_dict             *extensions,
    void                    *userarg,
    getdns_transaction_t    *transaction_id,
    getdns_callback_t        callbackfn
);
```

- With address:

```
{
  "address_type": <bindata of "IPv4">
  "address_data": <bindata for 185.49.141.37>,
}
```

will lookup 37.141.49.185.in-addr.arpa PTR

Hands on getdns - SRV lookups

```
getdns_return_t getdns_service(
    getdns_context          *context,
    const char              *name,
    getdns_dict             *extensions,
    void                    *userarg,
    getdns_transaction_t    *transaction_id,
    getdns_callback_t        callbackfn
);
```

- Looks up SRV RRs

Hands on getdns - The response object

```
{
  "answer_type": GETDNS_NAMETYPE_DNS,
  "status": GETDNS_RESPSTATUS_GOOD,
  "canonical_name": <bindata of "www.getdnsapi.net.">,
  "just_address_answers":
  [
    {
      "address_data": <bindata for 185.49.141.37>,
      "address_type": <bindata of "IPv4">
    },
    {
      "address_data": <bindata for 2a04:b900:0:100::37>,
      "address_type": <bindata of "IPv6">
    }
  ],
  "replies_full":
  [
     <bindata of 0x000081800001000200040001037777777...>,
     <bindata of 0x000081800001000200040009037777777...>
  ],
  "replies_tree":
  [
    { ... first reply ... },
    { ... second reply ... },
```

Hands on getdns - The response object

```
"replies_tree":
[
  { "header"   : { "qdcount": 1, "ancount": 2, "rd": 1, "ra": 1,
                   "opcode": GETDNS_OPCODE_QUERY,
                   "rcode" : GETDNS_RCODE_NOERROR, ... },

    "question": { "qname" : <bindata for www.getdnsapi.net.>,
                  "qtype" : GETDNS_RRTYPE_A
                  "qclass": GETDNS_RRCLASS_IN, },

    "answer"   : [ { "name" : <bindata for www.getdnsapi.net.>,
                     "type" : GETDNS_RRTYPE_A
                     "class": GETDNS_RRCLASS_IN,
                     "rdata": { "ipv4_address": <bindata for 185.49.141.37>,
                                "rdata_raw": <bindata of 0xb9318d25> },
                   }, ...
    "authority": [ ... ],
    "additional": [],
    "canonical_name": <bindata of "www.getdnsapi.net.">,
    "answer_type": GETDNS_NAMETYPE_DNS
  },
  { "header"   : { ...
```

Hands on getdns - Data structures

- Data structure types to represent the response object

```
typedef struct getdns_dict getdns_dict;
typedef struct getdns_list getdns_list;
typedef struct getdns_bindata { size_t   size;
                                uint8_t *data; } getdns_bindata;
```

Hands on getdns - Data structures

- Data structure types to represent the response object

```
typedef struct getdns_dict getdns_dict;
typedef struct getdns_list getdns_list;
typedef struct getdns_bindata { size_t   size;
                                uint8_t *data; } getdns_bindata;
```

- And access, create and modify functions for them

```
getdns_list_get_length(const getdns_list *this_list, size_t *answer);
getdns_list_get_data_type(const getdns_list *this_list, size_t index, getdns_data_type *answer);
getdns_list_get_dict(const getdns_list *this_list, size_t index, getdns_dict **answer);
getdns_list_get_list(const getdns_list *this_list, size_t index, getdns_list **answer);
getdns_list_get_bindata(const getdns_list *this_list, size_t index, getdns_bindata **answer);
getdns_list_get_int(const getdns_list *this_list, size_t index, uint32_t *answer);
getdns_dict_get_names(const getdns_dict *this_dict, getdns_list **answer);
getdns_dict_get_data_type(const getdns_dict *this_dict, const char *name, getdns_data_type *answer);
getdns_dict_get_dict(const getdns_dict *this_dict, const char *name, getdns_dict **answer);
getdns_dict_get_list(const getdns_dict *this_dict, const char *name, getdns_list **answer);
getdns_dict_get_bindata(const getdns_dict *this_dict, const char *name, getdns_bindata **answer);
getdns_dict_get_int(const getdns_dict *this_dict, const char *name, uint32_t *answer);
getdns_list * getdns_list_create();
void getdns_list_destroy(getdns_list *this_list);
getdns_list_set_dict(getdns_list *this_list, size_t index, const getdns_dict *child_dict);
getdns_list_set_list(getdns_list *this_list, size_t index, const getdns_list *child_list);
getdns_list_set_bindata(getdns_list *this_list, size_t index, const getdns_bindata *child_bindata);
getdns_list_set_int(getdns_list *this_list, size_t index, uint32_t child_uint32);
getdns_dict * getdns_dict_create();
void getdns_dict_destroy(getdns_dict *this_dict);
getdns_dict_set_dict(getdns_dict *this_dict, const char *name, const getdns_dict *child_dict);
getdns_dict_set_list(getdns_dict *this_dict, const char *name, const getdns_list *child_list);
getdns_dict_set_bindata(getdns_dict *this_dict, ...
```

Hands on getdns - Data structures

- A bit involved and counter intuitive to use in C

```
struct getdns_dict *response;
r = getdns_address_sync(context, "www.getdnsapi.net",
    NULL, &response);
if (r != GETDNS_RETURN_GOOD) goto error;

struct getdns_list *replies_tree;
r = getdns_dict_get_list(response, "replies_tree",
    &replies_tree);
if (r != GETDNS_RETURN_GOOD) goto error;

struct getdns_dict *reply;
r = getdns_list_get_dict(replies_tree, 0, &reply);
if (r != GETDNS_RETURN_GOOD) goto error;

struct getdns_list *answer;
r = getdns_dict_get_list(reply, "answer", &answer);
if (r != GETDNS_RETURN_GOOD) goto error;
```

Hands on getdns - Data structures

- A bit involved and counter intuitive to use in C
- But pythonic

```
reponse = getdns.address(context, "www.getdnsapi.net")
answer = reponse["replies_tree"][0]["answer"]
```

- And javascript works well too...

```
var callback = function(err, response) {
    answer = reponse.replies_tree[0].answer;
}
context.getAddress("www.getdnsapi.net", callback);
```

Hands on getdns - Data structures

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```
reponse = getdns.address(context, "www.getdnsapi.net")
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- And javascript works well too...

```
var callback = function(err, response) {
    answer = reponse.replies_tree[0].answer;
}
context.getAddress("www.getdnsapi.net", callback);
```

- Python bindings by Melinda Shore
  Get them from `https://github.com/getdnsapi/getdns-python-bindings`
- Node (javascript) bindings by Neel Goyal
  Get them from `https://github.com/getdnsapi/getdns-node`
- More bindings will follow ...

Hands on getdns - Data structures

- A bit cumbersome and counter intuitive to use in C
- But pythonic
- And javascript works well too...

- Maps well to popular modern scripting languages
- and it provides a uniform grammar
- And the C interface has the virtue of extensibility
- New features don't need new function prototypes

Hands on getdns - Data structures

http://getdnsapi.net/query.html

getdnsapi.net | A | Query verzenden

- [x] return_both_v4_and_v6
- [x] dnssec_return_status
- [ ] dnssec_return_only_secure
- [ ] dnssec_return_validation_chain

```
{
  "answer_type": GETDNS_NAMETYPE_DNS,
  "canonical_name": <bindata of "getdnsapi.net.">,
  "just_address_answers":
  [
    {
      "address_data": <bindata for 185.49.141.37>,
      "address_type": <bindata of "IPv4">
    },
    {
      "address_data": <bindata for 2a04:b900:0:100::37>,
      "address_type": <bindata of "IPv6">
    }
  ],
```

Hands on getdns - Getting DNSSEC

dnssec_return_status

Returns security assertion. Omits bogus answers

```
{ # This is the response object
  "replies_tree":
  [
    { # This is the first reply
      "dnssec_status": GETDNS_DNSSEC_INSECURE,
```

"dnssec_status" can be GETDNS_DNSSEC_SECURE, GETDNS_DNSSEC_INSECURE or GETDNS_DNSSEC_INDETERMINATE

Thus **not** GETDNS_DNSSEC_BOGUS

Hands on getdns - Getting DNSSEC

`dnssec_return_status`

Returns security assertion. Omits bogus answers

```
{ # This is the response object
  "replies_tree":
  [
    { # This is the first reply
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```

"dnssec_status" can be GETDNS_DNSSEC_SECURE, GETDNS_DNSSEC_INSECURE or GETDNS_DNSSEC_INDETERMINATE

`dnssec_return_only_secure` The DANE extension

Returns security assertion. Omits bogus and insecure answers

```
{ # This is the response object
  "replies_tree": [],
  "status" : GETDNS_RESPSTATUS_NO_SECURE_ANSWERS,
```

Hands on getdns - Getting DNSSEC

`dnssec_return_status`

Returns security assertion. Omits bogus answers

```
{ # This is the response object
  "replies_tree":
  [
    { # This is the first reply
      "dnssec_status": GETDNS_DNSSEC_INSECURE,
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`dnssec_return_only_secure` The DANE extension

Returns security assertion. Omits bogus and insecure answers

```
{ # This is the response object
  "replies_tree": [],
  "status" : GETDNS_RESPSTATUS_NO_SECURE_ANSWERS,
```

`dnssec_return_validation_chain`

Now "dnssec_status" can also be GETDNS_DNSSEC_BOGUS

Hands on getdns - Getting DNSSEC

`dnssec_return_status`

Returns security assertion. Omits bogus answers

```
{ # This is the response object
  "replies_tree":
  [
    { # This is the first reply
      "dnssec_status": GETDNS_DNSSEC_INSECURE,
```

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`dnssec_return_only_secure` The DANE extension

Returns security assertion. Omits bogus and insecure answers

```
{ # This is the response object
  "replies_tree": [],
  "status" : GETDNS_RESPSTATUS_NO_SECURE_ANSWERS,
```

`dnssec_return_validation_chain`

Now "dnssec_status" can also be GETDNS_DNSSEC_BOGUS

`getdns_context_set_return_dnssec_status(context)` Just us :(

Hands on getdns - Get the validation chain

- dnssec_return_validation_chain extension:

```
{ # Response object
  "validation_chain":
  [ { "name" : <bindata for .>, "type": GETDNS_RRTYPE_DNSKEY, ... },
    { "name" : <bindata for .>, "type": GETDNS_RRTYPE_DNSKEY, ... },

    { "name" : <bindata for .>, "type": GETDNS_RRTYPE_RRSIG,
      "rdata": { "signers_name": <bindata for .>,
                 "type_covered": GETDNS_RRTYPE_DNSKEY, ... }, ... },

    { "name" : <bindata for net.>, "type": GETDNS_RRTYPE_DS, ... },
    { "name" : <bindata for net.>, "type": GETDNS_RRTYPE_RRSIG,
      "rdata": { "signers_name": <bindata for .>,
                 "type_covered": GETDNS_RRTYPE_DS, ... }, ... },
```

Hands on getdns - Get the validation chain

- dnssec_return_validation_chain extension:

```
{ # Response object
  "validation_chain":
  [ { "name" : <bindata for .>, "type": GETDNS_RRTYPE_DNSKEY, ... },
    { "name" : <bindata for .>, "type": GETDNS_RRTYPE_DNSKEY, ... },

    { "name" : <bindata for .>, "type": GETDNS_RRTYPE_RRSIG,
      "rdata": { "signers_name": <bindata for .>,
                 "type_covered": GETDNS_RRTYPE_DNSKEY, ... }, ... },

    { "name" : <bindata for net.>, "type": GETDNS_RRTYPE_DS, ... },
    { "name" : <bindata for net.>, "type": GETDNS_RRTYPE_RRSIG,
      "rdata": { "signers_name": <bindata for .>,
                 "type_covered": GETDNS_RRTYPE_DS, ... }, ... },
```

- Feed to getdns_validate_dnssec to validate the chain

```
getdns_return_t
getdns_validate_dnssec(
    getdns_list *to_validate,     // The answer
    getdns_list *support_records, // The "validation_chain"
    getdns_list *trust_anchors    // getdns_root_trust_anchor()
);
```

Look for yourself at **http://getdnsapi.net/query.html**

Hands on getdns - Asynchronous

From API 1.8 Event-driven Programs

Each implementation of the DNS API will specify an extension function that tells the DNS context which event base is being used.

libevent

include `#include <getdns/getdns_ext_libevent.h>`

use `getdns_extension_set_libevent_base(context, base);`

link `-lgetdns -lgetdns_ext_event`

```
struct event_base *base = event_base_new();
getdns_extension_set_libevent_base(context, base);

getdns_address(context, "getdnsapi.net",
    NULL, NULL, NULL, callback);

event_base_dispatch(base);
event_base_free(base);
```

Hands on getdns - Asynchronous

From API 1.8 Event-driven Programs

Each implementation of the DNS API will specify an extension function that tells the DNS context which event base is being used.

libevent

```
include   #include <getdns/getdns_ext_libevent.h>
    use   getdns_extension_set_libevent_base(context, base);
   link   -lgetdns -lgetdns_ext_event
```

libev

```
include   #include <getdns/getdns_ext_libev.h>
    use   getdns_extension_set_libev_loop(context, loop);
   link   -lgetdns -lgetdns_ext_ev
```

libuv

```
include   #include <getdns/getdns_ext_libuv.h>
    use   getdns_extension_set_libuv_loop(context, loop);
   link   -lgetdns -lgetdns_ext_uv
```

Hands on getdns - Asynchronous

From API 1.8 Event-driven Programs

Each implementation of the DNS API will specify an extension function that tells the DNS context which event base is being used.

```
int getdns_context_fd(getdns_context *context)
    /* Call the event loop */
    while (getdns_context_get_num_pending_requests(context, &tv)
        int fd = getdns_context_fd(context);
        fd_set read_fds;
        FD_ZERO(&read_fds);
        FD_SET(fd, &read_fds);
        select(fd + 1, &read_fds, NULL, NULL, &tv);
        if (getdns_context_process_async(context) != GETDNS_RETUR
            // context destroyed
            break;
        }
    }
```

Road map

Missing extensions

- `specify_class`, `add_warning_for_bad_dns`, `return_call_debugging`, `add_opt_parameter`

  Te get to hop-to-hop controls (i.e. EDNS0)
  stub needs to be replaced with ldns resolver

  John & Sara Dickinson on board to help with the effort.
  Deadline: 20 July (before IETF90)

More language bindings, more platforms, more name systems

- Perl, Ruby
- MS-Windows, Android
- local files, WINS, mDNS, NIS

More C-like C-interface (specific for our implementation)

Optimizations

- Current data structures are build and need a lot of mallocs
- On top of the data structures of ldns
- Accessor functions on the wire data + Just In Time parsing

Gives applications DNSSEC

website	`http://getdnsapi.net`
github repo	`http://github.nl/getdnsapi/getdns`
python repo	`http://github.nl/getdnsapi/getdns-python-bindings`
node repo	`http://github.nl/getdnsapi/getdns-node`
mailing-list	`http://getdnsapi.net/mailman/listinfo/users`
API website	http://www.vpnc.org/getdns-api
API list	http://www.vpnc.org/mailman/listinfo/getdns-api
me	Willem Toorop <willem@nlnetlabs.nl>

Application will bootstrap encrypted channels with DANE

What is your role in this?