getaddrinfo sucks Everything else is much worse



Valentin Goșu

Senior Staff Engineer, Firefox Networking team (Necko)

Native of \blacksquare residing in \blacksquare

valentin@mozilla.com

https://fosstodon.org/@valenting

I 💖 emoji.

Natural Introvert. Please come say hi. 🙂



Full disclosure

- 01 Yes, the title is clickbait
- No, getaddrinfo doesn't really 02 suck
- 03 Unless you want to use it for something it can't do.
- 04 This talk may include rants
- 05 I rarely know what I'm doing 🤪



getaddrinfo

Timeline of getaddrinfo

	RFC 213 Socket 1 Extension IPv6 April 19		erface	RFC 3493 February 20	003	
	Protocol Independent Interfaces, IEEE Std 1003.1g DRAFT 6.3		RFC 2553 March 1999)		
^I November 1995						I3

getaddrinfo

```
int getaddrinfo(const char *nodename, const char *servname,
               const struct addrinfo *hints, struct addrinfo **res);
void freeaddrinfo(struct addrinfo *ai);
struct addrinfo {
  int
         ai flags; /* AI PASSIVE, AI CANONNAME,
                      AI NUMERICHOST, .. */
                     /* AF_xxx */
  int ai family;
      ai_socktype; /* SOCK_xxx */
  int
  int
         ai_protocol; /* 0 or IPPROTO_xxx for IPv4 and IPv6 */
  socklen t ai addrlen; /* length of ai addr */
        *ai_canonname; /* canonical name for nodename */
  char
  struct sockaddr *ai addr; /* binary address */
  struct addrinfo *ai next; /* next structure in linked list */
};
```

What's great about getaddrinfo?

- 1 It's simple
- 2 It works!
- It's well documented
- It's available on all platforms
- It works (roughly) the same on all platforms

What sucks about getaddrinfo?

- It's a synchronous API
- 2 It is very limited
- It doesn't expose full response details (TTL, EDNSO, rcode, CNAME chain)
- Minor implementation differences do exist
- No way to control caching or use of /etc/hosts

How getaddrinfo is used in Firefox

- Thread pool for calling getaddrinfo
- nsHostResolver has request queues with different priorities.
- Each thread checks the queues in order and calls getaddrinfo
- Caching (Firefox DNS cache, OS DNS cache, ISP DNS cache)
- **■** TTLs
- DNSQuery_A on Windows (only for getting TTL values)

Enter DNS over HTTPS (RFC 8484)

- Firefox needed a DNS packet parser for DoH
- No longer sync just one thread that polls the socket and parses responses
- We now have TTL values
- Can parse different responses such as CNAME, TXT, OPT
- SVCB/HTTPS RR
- Trusted Recursive Resolver (TRR) vs DNS over HTTPS (DoH)

SVCB/HTTPS Resource Records (RFC 9460)

User tries to load http://example.com

\$ORIGIN example.com. www 7200 IN HTTPS 1 . alpn=h2 www 7200 IN HTTPS 2 . alpn=h3 port=8443

This host has a HTTPS record:

- No plain-text HTTP.
- The host supports HTTP/2 on the default port
- For HTTP/3, we can connect to port 8443
 - the URL bar will still show https://www.example.com (note that the origin will still be www.example.com:443 - default HTTPS port).

ipv4hint, ipv6hint, ech

What about non DoH clients?

Why use native APIs for HTTPS RR

- using the same resolver as the rest of the OS
- OS cache
- Easier implementation?

Expectations for native APIs

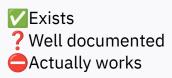
- **Exists**
- Well documented
- Actually works

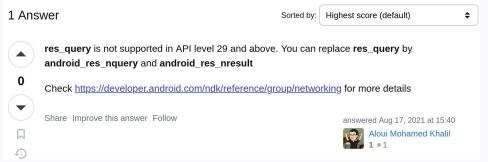
Linux: res_nquery

```
✓ Exists✓ Well documented✓ Actually works
```

Android: res_query







Android: android_res_nquery

```
void* handle = dlopen("libandroid_net.so", RTLD_LAZY);
auto android_res_nquery = (int (*)(...)) dlsym(handle, "android_res_nquery");
int resp_handle = android_res_nquery(0, "google.com", ns_c_in, 65, 0);
struct pollfd fds;
fds.fd = resp_handle;
fds.events = POLLIN; // Wait for read events
// Wait for an event on the file descriptor
int ret = poll(\&fds, 1, -1); // -1 means no timeout
char answer[3200]:
ssize t bytes received = recv(resp handle, answer, 3200 - 1, 0);
// First 8 bytes in answer are the UDP header.
```

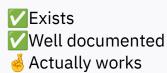
Android: android_res_nquery

Only available on Android 10+

What I like about it:

- Can specify caching (does it work? 💁)
- Can specify network interface

```
ResNsendFlags{
    ANDROID_RESOLV_NO_RETRY = 1 << 0,
    ANDROID_RESOLV_NO_CACHE_STORE = 1 << 1,
    ANDROID_RESOLV_NO_CACHE_LOOKUP = 1 << 2
}
android_res_nquery(net_handle_t network, const char *dname, int ns_class, int ns_type, uint32_t flags)</pre>
```



Windows: DNSQuery_A

```
PDNS RECORD result = nullptr;
DNS STATUS DnsQuery A(
            PCSTR
 [in]
                      pszName,
                                                     DNS STATUS status = DnsQuery_A(
 [in]
            WORD
                      wType,
                                                           host.c str(),
            DWORD
 [in]
                       Options.
                                                           65, // Type 65 corresponds to HTTPS record
 [in, out, optional] PVOID
                           pExtra,
                                                           DNS_QUERY_STANDARD,
 [out, optional] PDNS_RECORD *ppQueryResults,
                                                           nullptr, &result, nullptr
 [out, optional] PVOID
                         *pReserved
                                                     if (status != ERROR SUCCESS) {
                                                            LOG("DnsQuery_A failed with error: %ld", status);
                                                           return false;
```

✓Exists ✓Well documented Actually works

Windows 10 HTTPS RR bug: https://aka.ms/AAo4y7b Please upvote https://aka.ms/AAo4y7b

LOG("result %p", result); // This is NULL on Windows 10! 😭

Windows: DNSQuery_A

```
PDNS RECORDA dnsData = nullptr:
DNS STATUS status = DnsQuery A(aHost.BeginReading(), regFamily, aFlags,
                               nullptr, &dnsData, nullptr);
if (status == DNS INFO NO RECORDS || status == DNS ERROR RCODE NAME ERROR ||
 LOG("No DNS records found for %s. status=%lX. regFamily = %X\n",
      aHost.BeginReading(), status, regFamily);
  return NS ERROR FAILURE:
} else if (status != NOERROR) {
  LOG WARNING("DnsQuery A failed with status %lX.\n", status);
  return NS ERROR UNEXPECTED:
for (PDNS RECORDA curRecord = dnsData: curRecord:
     curRecord = curRecord->pNext) {
  // Only records in the answer section are important
  if (curRecord->Flags.S.Section != DnsSectionAnswer) {
  if (curRecord->wType != regFamily) {
  aCallback(curRecord):
DnsFree(dnsData, DNS FREE TYPE::DnsFreeRecordList);
return NS OK:
```

```
DNS TLSA DATA
                         Tlsa;
    DNS SVCB DATA
                         SVCB;
    DNS SVCB DATA
                         Svcb;
    DNS UNKNOWN DATA
                         UNKNOWN;
                         Unknown;
    DNS UNKNOWN DATA
    PBYTE
                         pDataPtr;
  } Data;
} DNS_RECORDA, *PDNS_RECORDA;
```

DNS query options

Constant	Value	Meaning
DNS_QUERY_STANDARD	0x00000000	Standard query.
DNS_QUERY_ACCEPT_TRUNCATED_RESPONSE	0x00000001	Returns truncated results. Does not retry under TCP.
DNS_QUERY_USE_TCP_ONLY	0x00000002	Uses TCP only for the query.
DNS_QUERY_NO_RECURSION	0x00000004	Directs the DNS server to perform an iterative query (specifically directs the DNS server not to perform recursive resolution to resolve the query).
DNS_QUERY_BYPASS_CACHE	0x00000008	Bypasses the resolver cache on the lookup.
DNS_QUERY_NO_WIRE_QUERY	0x00000010	Directs DNS to perform a query on the local cache only.Windows 2000 Server and Windows 2000 Professional: This value is not supported. For similar functionality, use DNS_QUERY_CACHE_ONLY.
DNS_QUERY_NO_LOCAL_NAME	0x00000020	Directs DNS to ignore the local name. Windows 2000 Server and Windows 2000 Professional: This value is not supported.
DNS_QUERY_NO_HOSTS_FILE	0x00000040	Prevents the DNS query from consulting the HOSTS file.Windows 2000 Server and Windows 2000 Professional: This value is not supported.
DNS_QUERY_NO_NETBT	0x00000080	Prevents the DNS query from using NetBT for resolution.Windows 2000 Server and Windows 2000 Professional: This value is not supported.
DNS_QUERY_WIRE_ONLY	0x00000100	Directs DNS to perform a query using the network only, bypassing loca information. Windows 2000 Server and Windows 2000 Professional: This value is not supported.
DNS_QUERY_RETURN_MESSAGE	0x00000200	Directs DNS to return the entire DNS response message. Windows 2000 Server and Windows 2000 Professional: This value is not supported.
DNS_QUERY_MULTICAST_ONLY	0x00000400	Prevents the query from using DNS and uses only Local Link Multicast Name Resolution (LLMNR).Windows Vista and Windows Server 2008 or later: This value is supported.
DNS_QUERY_NO_MULTICAST	0x00000800	
DNS OLIERY TREAT AS FORM	0.00001000	Prevente the DNS reconnee from attaching cuffives to the culmitted

```
typedef struct {
 IP4_ADDRESS IpAddress;
} DNS_A_DATA, *PDNS_A_DATA;
```

nsresult rv = DNSPacket::ParseHTTPS(current->wDataLength, parsed, 0, ptr, current->wDataLength, aHost);

Expand table

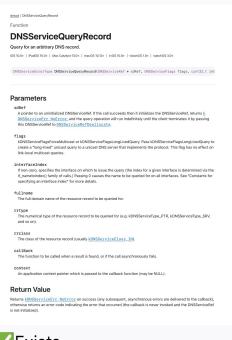
MacOS: res_query

Bug 1882856 - Crash in [@ dns res send] with "network.dns.native https guery" on MacOS

Only use this if your application is single threaded. This is not thread safe.

- Exists
- ? Well documented
- Actually works

MacOS: DNSServiceQueryRecord



```
ExistsWell documented
```

```
void queryRecordCallback(DNSServiceRef sdRef, DNSServiceFlags flags, uint32 t interfaceIndex,
DNSServiceErrorType errorCode, const char *fullname, uint16_t rrtype, uint16_t rrclass,
uint16 t rdlen, const void *rdata, uint32 t ttl, void *context
       if (errorCode == kDNSServiceErr NoError) {
         printf("Received record for: %s\n", fullname);
       } else {
         printf("Error querving record: %d\n", errorCode);
DNSServiceRef sdRef:
DNSServiceErrorType error = DNSServiceQueryRecord(&sdRef, 0, 0, "google.com",
       1, kDNSServiceClass IN, queryRecordCallback, nullptr);
if (error != kDNSServiceErr NoError) {
       printf("Error starting query: %d\n", error);
       return:
DNSServiceProcessResult(sdRef); // Calls the callback
DNSServiceRefDeallocate(sdRef):
```

MacOS: DNSServiceQueryRecord

Bug 1941128 - Tabs hang in DNS lookups on macOS after bug 1938293

If the domain/HTTPS RR doesn't exist, the callback never gets called! 🤯 🤦 😱

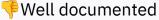


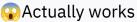




WAT?!?







MacOS: DNSServiceQueryRecord

```
void queryRecordCallback(...)
) {
       if (errorCode == kDNSServiceErr_NoError) {
         printf("Received record for: %s\n", fullname);
       } else {
         printf("Error querying record: %d\n", errorCode);
DNSServiceRef sdRef:
DNSServiceErrorType error =
DNSServiceQueryRecord(&sdRef, 0, 0, host.c_str(),
       1, kDNSServiceClass IN, queryRecordCallback,
nullptr):
if (error != kDNSServiceErr NoError) {
       printf("Error starting query: %d\n", error);
       return;
```

```
int fd = DNSServiceRefSockFD(sdRef);
fd_set readfds;
FD_ZERO(&readfds);
FD SET(fd, &readfds):
struct timeval timeout:
timeout.tv_sec = 30; // 30-second timeout
timeout.tv usec = 0:
int result = select(fd + 1, &readfds, NULL, NULL, &timeout);
if (result > 0 && FD_ISSET(fd, &readfds)) {
       // Process the result
       DNSServiceProcessResult(sdRef);
} else if (result == 0) {
       printf("select() timed out\n");
} else if (result < 0) {
       printf("select() failed\n");
DNSServiceRefDeallocate(sdRef);
```

Lessons learned

- The API capabilities vary widely across platforms.
- An abstraction library would be nice.
- Sometimes implementing your own DNS client might be worth it. Or use an existing one.
- When using these APIs document & blog about your experience.

What API would I like?

- DnsQuery_A/Ex lots of options for caching, /etc/hosts, network, protocol
- android_res_query access to the socket and response bytes
- Better control over request bytes as well.
- Like getaddrinfo I'd like something that works well everywhere!

Thank you