Porting to Dual Stack -- Not that hard

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Why is this important?

v4 Exhaustion

IPv4 & IPv6 Statistics

v4 Addresses
433,525,008

v4 /8s Left
10% (26/256)

v6 Networks
5% (1,713/32,780)

v6 Ready TLDs
80% (224/280)

v6 Glue
1,580

v6 Domains
1,482,572

726 Days remaining

HURRICANE ELECTRIC

INTERNET SERVICES
Apologies in advance for the Text-Fest
Summary of Porting Steps

- Sample code and other resources available at:  http://owend.corp.he.net/ipv6/
- Change variable names when changing types. (e.g. dest_sin -> dest6_sin)
- Look for old variable name(s) as markers for code to be updated.
- Compile->Repair->Recompile (iterative)
- Test->Debug->Retest (iterative)
General Changes (IPv4 to dual stack)

- AF_INET -> AF_INET6
- sockaddr_in -> sockaddr_in6, sockaddr_storage (Generic storage type)
- Same structure members, similar constants, mostly just the address size changes.
- If necessary, check address scoping (link local vs. global and interface scope for link locals)
Some possible gotchas not covered in the examples

- IP Addresses in logs
- IP Addresses stored in databases
- Parsing or other routines that need to deal with IP addresses (use library functions if at all possible)
What happens if we aren’t ready?
PERL Porting Example

- Refer to the Source Code Examples
- v4_* are IPv4 only code
- v6_* are same applications ported to dual stack
- Did not rename most variables in this example. (Small codebase, not as important)
Server Differences (PERL)

- Add Socket6 to the modules “used” (you still need Socket, too). PERL documentation for Socket6 is minimal and examples limited.
- Gut and replace get*byname calls (more on this next slide)
- Change protocol and address families in socket() and bind() calls.
- Minor changes to processing incoming connections (mostly related to name/address display).
Server Differences (PERL) (cont.)

- Biggest change is conversion from get*bbyname() to getaddrinfo()
- Similar changes to C port (same underlying library changes)
- C getaddrinfo() returns linked list. PERL getaddrinfo() returns straight list (multiple of 5 elements, each 5 elements is a list entry).
- Gotcha on getaddrinfo() -- passing in in6addr_any does not return in6addr_any.
No, really, what happens?

Communication between IPv4 nodes and IPv6 nodes

IPv4-only

IPv4-only

translation router

IPv6-only (IPv4 compat. addr.)

TCP relay

IPv6-only (IPv6 addr.)
Code Changes (PERL)

- **Old way (getservbyname()):**

  ```perl
  my $tcp = getprotobynamel('tcp');
  my $tcpport = getservbyname('demo', 'tcp');
  ```

- **New way (getaddrinfo()):**

  ```perl
  my ($fam, $stype, $tcp, $saddr, $cname);
  my @res = getaddrinfo(in6addr_any(), 'demo', AF_UNSPEC, SOCK_STREAM);
  my ($tcpport, $addr);
  die "$0: Could not get protocol information" unless @res;
  # This is ugly, but, seems to be necessary to bind to IPv6.
  $fam = 0;
  ($fam, $stype, $tcp, $saddr, $cname, @res) = @res while $fam != AF_INET6;
  die "$0: IPv6 unsupported on this system.
  $addr = in6addr_any();
  $saddr = pack_sockaddr_in6($tcpport, $addr);
  ```
Code Changes (PERL) (Cont.)

- **IPv4 only:**
  ```perl
  socket(TCPServer, PF_INET, SOCK_STREAM, $tcp) ||
  die "$0: Could not create socket: $!";
  bind(TCPServer, sockaddr_in($tcpport, INADDR_ANY)) ||
  die "$0: Bind failed: $!";
  ```

- **IPv4/v6 Dual Stack:**
  ```perl
  socket(TCPServer, PF_INET6, SOCK_STREAM, $tcp) ||
  die "$0: Could not create socket: $!";
  bind(TCPServer, $saddr) || die "$0: Bind failed: $!";
  ```
Code Changes (PERL) (Cont.)

- IPv4 only:

```perl
my ($port, $iaddr) = sockaddr_in($paddr);
my $name = gethostbyaddr($iaddr, AF_INET);
debug(5, "TCP Connection from $name [".inet_ntoa($iaddr)."] at port $port.\n");
$CLIENTS{$CLIENT} = inet_ntoa($iaddr)."/".$port;
```

- IPv4/v6 Dual Stack:

```perl
my ($port, $iaddr) = unpack_sockaddr_in6($paddr);
my ($name, $svc) = getnameinfo($paddr);
debug(5, "TCP Connection from $name [".inet_ntop(AF_INET6, $iaddr).
    "] at port $port.\n");
$CLIENTS{$CLIENT} = inet_ntop(AF_INET6, $iaddr)."/".$port;
```
PERL Client Migration

- Similar changes to C client
- Add module Socket6 (just like the server)
- Rearrange the address resolution stuff for getaddrinfo()
- Add some handling for AF_INET6 to the connection loop
- Convert inet_ntoa() to inet_ntop() calls.
- Handle Protocol Family for socket() call
IPv4 only:

```perl
my $tcp = getprotobynumber('tcp');
my $tcpport = getservbyname($port, 'tcp');
...
my ($name, $aliases, $addrtype, $length, @addrs) = gethostbyname($server);
die("$0: gethostbyname error: $!
") if ($?);
die("Invalid server specified.");
socket(SOCKFD, PF_INET, SOCK_STREAM, $tcp) || die "Couldn't create socket: $!
";
SOCKFD->autoflush(1);
```

IPv4/v6 Dual Stack:

```perl
my @res = getaddrinfo($server, 'demo', AF_UNSPEC, SOCK_STREAM, 'tcp');
die("Could not resolve $server or service demo: ".

    unless(scalar(@res) >= 5);
```

Note: In IPv4, socket can be recycled for multiple
connects. IPv4/v6 Dual Stack, not so due to
possible family change (PF_INET/PF_INET6)
IPv4 only:

```perl
while (@addrs)
{
    $a = shift(@addrs);
    print "Trying host ", inet_ntoa($a), ".\n";
    $dest_sin = sockaddr_in($tcpport, $a);
    last if(connect(SOCKFD, $dest_sin));
    print "Failed to connect to ", inet_ntoa($a), "\n";
    $dest_sin = -1;
}
```
IPv4/v6 Dual Stack:

```perl
my ($fam, $stype, $proto, $saddr, $cname);
my ($port, $addr);
while (scalar(@res) >= 5)
  ($fam, $stype, $proto, $saddr, $cname, @res) = @res;
next unless($saddr);
$cname = $server unless $cname;
print "Unpacking $cname...";
($port, $addr) = ($fam == AF_INET6) ?
  unpack_sockaddr_in6($saddr) : sockaddr_in($saddr);
$addr = inet_ntop($fam, $addr);
print "Trying host $cname ($addr) port $port.\n";
my $PF = ($fam == AF_INET6) ? PF_INET6 : PF_INET;
socket(SOCKFD, $PF, SOCK_STREAM, $proto) || die "Couldn't create socket: $!\n";
SOCKFD->autoflush(1);
last if(connect(SOCKFD, $saddr));
close SOCKFD;
print "Failed to connect to $cname ($addr): $!\n";
$saddr = -1;
```

This isn’t as bad as it looks. Need better libraries?
Remember this classic? (Apologies to DRC)

Quiz Time!

You’re driving towards an invisible brick wall at 60 MPH, what do you do?

A. Accelerate. It will encourage brick wall removal.
B. Set cruise control and close your eyes. “We’ll all hit the wall at once”.
C. Slow down. Figure out if maybe getting out of the car makes sense.
# Function Replacement Guide (all languages)

<table>
<thead>
<tr>
<th>Old Function</th>
<th>Current Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>get<em>by</em>()</td>
<td>getaddrinfo(), getnameinfo()</td>
</tr>
<tr>
<td>socket()</td>
<td>socket()†</td>
</tr>
<tr>
<td>bind()</td>
<td>bind()†</td>
</tr>
<tr>
<td>listen()</td>
<td>listen()</td>
</tr>
<tr>
<td>connect()</td>
<td>connect()†</td>
</tr>
<tr>
<td>recv*()</td>
<td>recv*()†</td>
</tr>
<tr>
<td>send*()</td>
<td>send*()†</td>
</tr>
<tr>
<td>accept()</td>
<td>accept()</td>
</tr>
<tr>
<td>read()/write()</td>
<td>read()/write()</td>
</tr>
<tr>
<td>inet_ntoa()/inet_aton()</td>
<td>inet_ntop()/net_pton() or getnameinfo()†</td>
</tr>
</tbody>
</table>

† parameters change for IPv6 support
# Structure Replacement Guide

<table>
<thead>
<tr>
<th>Old Structure</th>
<th>Current Structure</th>
</tr>
</thead>
<tbody>
<tr>
<td>sockaddr_in, sockaddr_storage†</td>
<td>sockaddr_in6, sockaddr_storage†</td>
</tr>
<tr>
<td>in_addr, int (Don’t do this, even in v4 only)</td>
<td></td>
</tr>
<tr>
<td>hostent</td>
<td>addrinfo</td>
</tr>
<tr>
<td>servent</td>
<td></td>
</tr>
</tbody>
</table>

†sockaddr_storage is a pointer type only can point to either actual type.
Q&A

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Copy of slides available at:
http://owend.corp.he.net/ipv6/PortMeth.pdf

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