

# **Assuring High Availability of Critical Services in the Internet of the Future**

Bill Woodcock  
Research Director  
Packet Clearing House

# **A Definition of Critical Services**

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Critical services in communications networks are those that, when they fail, cause the failure of communication for a significant portion of the users.

A particular domain name server is not critical.

The ability to resolve domain names generally, is.

A particular router is not critical.

The ability of the Internet to route traffic generally, is.

# How Does the Internet Route Traffic?

Internet bandwidth is produced in Internet Exchange Points, or IXPs, and transported to users by Internet Service Providers, or ISPs.

Although there are more than 300 IXPs globally, they're located in only 84 countries.

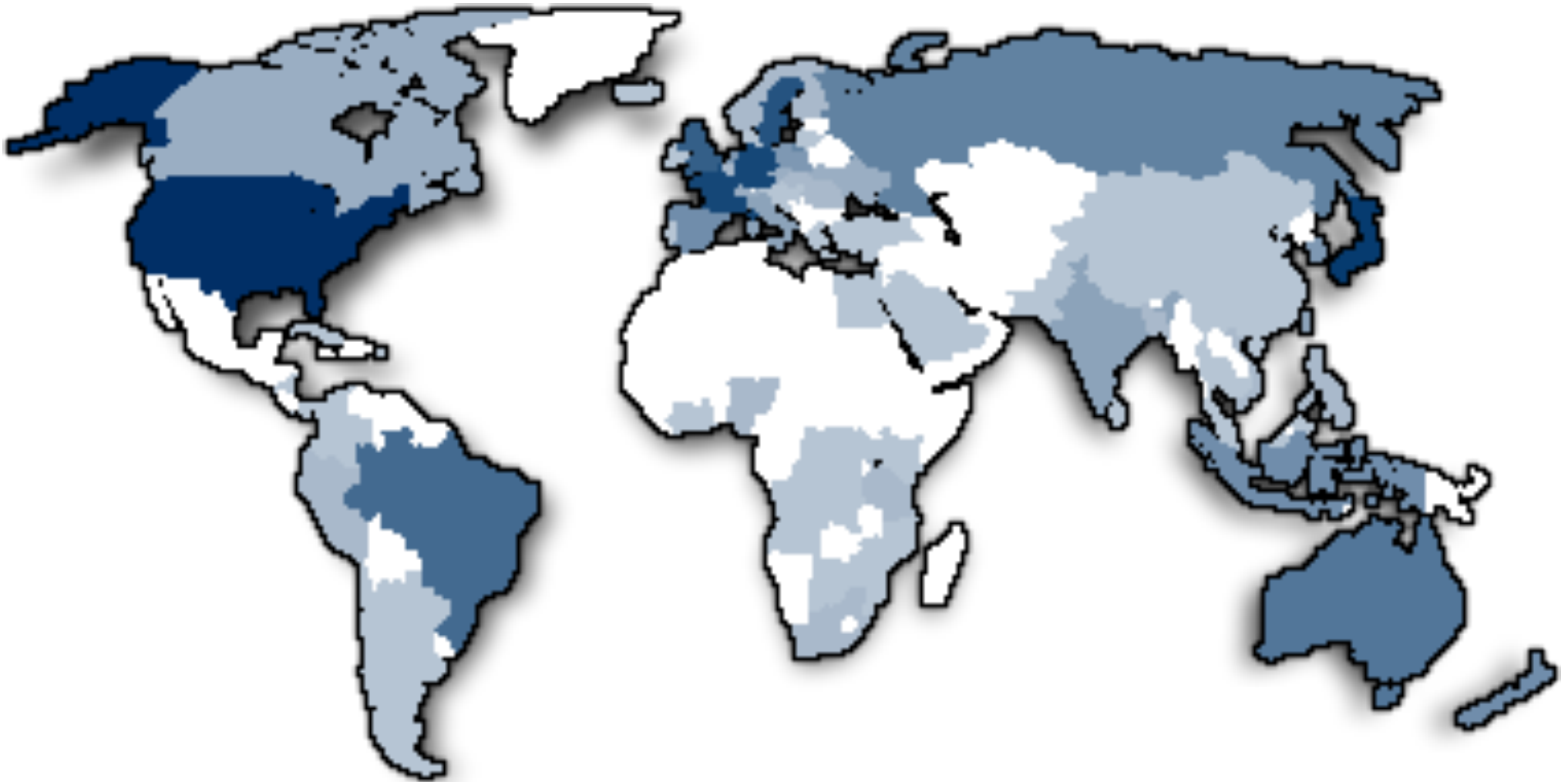
111 countries still don't have even a single IXP.

Those countries are entirely dependent for their Internet connectivity upon bandwidth expensively imported from countries which do have IXPs.

# Distribution of Internet Exchange Points

United States: 88	Switzerland: 3
Japan: 17	Czech Republic: 3
Germany: 13	Tanzania: 3
France: 13	Ukraine: 3
Sweden: 12	Viet Nam: 3
England: 11	Bangladesh: 2
Brazil: 10	Belgium: 2
Australia: 9	Ecuador: 2
Russia: 7	Estonia: 2
Spain: 6	Finland: 2
Indonesia: 6	Hong Kong: 2
New Zealand: 6	Nigeria: 2
Korea: 5	Norway: 2
Netherlands: 5	Peru: 2
Poland: 5	Philippines: 2
India: 4	Romania: 2
Italy: 4	Singapore: 2
Taiwan: 4	Slovakia: 2
Canada: 3	South Africa: 2

# Distribution of Internet Exchange Points



# Distribution of IPv6-Enabled Exchanges



# How Do We Solve This Problem?

The cost of building a new Internet Exchange Point is minimal, often less than US\$5,000.

Even the 99th percentile largest exchanges typically cost less than US\$500,000.

Return on this investment is measured in hours or days.

This has been done three hundred times before...

The work is in education, not engineering or financing.

# Criticality in the Domain Name System

The process of resolving the domain name that a user types in a URL or email address to a machine-readable Internet address is an iterative one.

It requires that several servers each answer in turn.

If any of those servers is unreachable, users will be unable to reach their destinations.

# Criticality in the Domain Name System

Typically these servers consist of:

A root nameserver, which refers queries to

A top-level domain (TLD) nameserver, which refers to

A second-level domain (SLD) nameserver.

# Criticality in the Domain Name System

Root nameservers need to be present in every IXP.

Nameservers for any country-code top-level domain (ccTLD) need to be present in every IXP in the country they serve, as well as in all major trading partners, and a few in the well-connected core of the Internet.

Second-level domain nameservers are the responsibility of the individual organizations they serve, and are not critical to the function of the Internet as a whole.

Every major population center needs an Internet exchange point, in order to locally produce the Internet bandwidth that it consumes.

Every Internet exchange point should have instances of both root nameservers and top-level domain nameservers, to ensure that users will be able to resolve domain names.

Neither of these are expensive or difficult tasks.