Geographic Locations of Web Servers under African Domains

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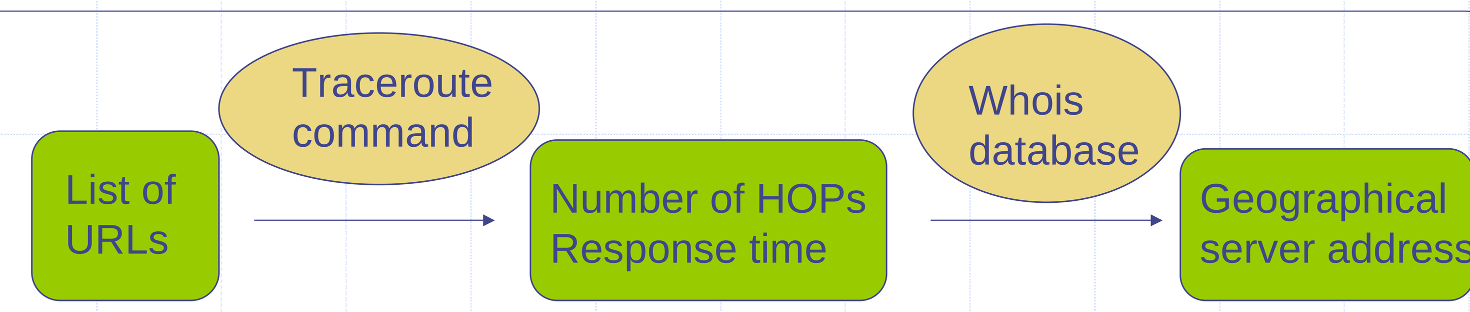
Abstract

The ccTLD (country code Top Level Domain) in a URL does not necessarily point to the geographic location of the server concerned. The authors have surveyed sample servers belonging to 60 ccTLDs in Africa, with regard to the number of hops required to reach the target site from Japan, the response time, and the NIC registration information of each domain. The survey has revealed the geographical distribution of server sites as well as their connection environments. It has been found that the percentage of offshore (out of home country) servers is as high as 80% and more than half of these are located in Europe. Offshore servers not only provide little benefit to the people of the country to which each ccTLD rightly belongs but their existence also heightens the risk of a country being unable to control them with its own policies and regulations. Offshore servers constitute a significant aspect of the digital divide problem.

Methodology

The authors have surveyed approximately 1600 websites that use ccTLDs of countries in the African Continent. We have used a traceroute command to measure the number of hops required to access each target site from the authors' university and the corresponding response time. In addition, we have applied Whois to the IP address of each server to derive the location information of each server (the country where the entity providing the server is located).



Offshore Server Percentage

Ex.) www.example.ac (Ascension Island) → If geographical address is

- "AC" (Define "Domestic" installations)
- NOT "AC" (Define "Offshore" installations)

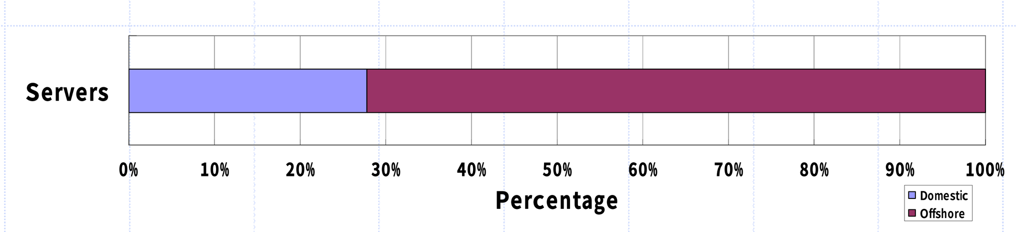


Figure 1: Ratio of domestic installations of surveyed servers under African ccTLDs.

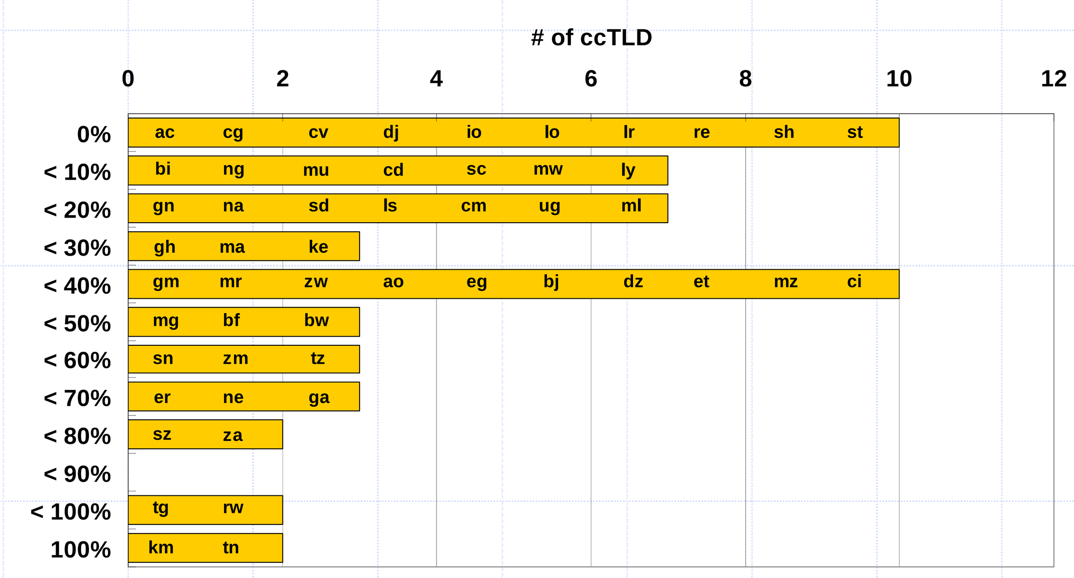


Figure 2: Distribution of domestic installations of surveyed severs under African ccTLDs.

The majority of African domains have fewer than 50% domestic installations.

Of the about 2400 servers used as samples in this survey, approximately 30% of them are located in the countries represented by the ccTLDs.

It is to be noted that ten domains have no domestic installations. Some of them, such as io (British Indian Ocean Territories) and ac (Ascension Island), are used for web hosting for marketing reasons. However, there are other ccTLDs with no clear mnemonic appeal.

ccTLD with mnemonic appeal

.ac(Ascension Island) : Academic

.dj(Djibouti) : Disc Jockey

Response Time and Number of HOPs

The reason for installing servers offshore is most likely due to an inferior domestic telecommunications infrastructure.
In fact, there are significant differences in response time between servers installed domestically and those offshore.

Figure 3 shows, servers were divided into two groups.

→ The response time has a difference that depend on the geographical location of the server

Group 1 → Domestic servers (probably through VSAT)

Group 2 → Mostly Offshore servers

Several national government sites are located outside their countries.
(For example,"A"in Figure 3 is the site for the Mali Ministry of Culture, located in Netherlands.)

Internet links from Japan reach IXPs in the African Continent via submarine cables, such as SAFE and SEAMEWE. The number of hops to these IXPs is comparable to that to offshore servers.

→ For example, "B" in Figure 3 represents Kigali RINEX, the IXP of Rwanda.

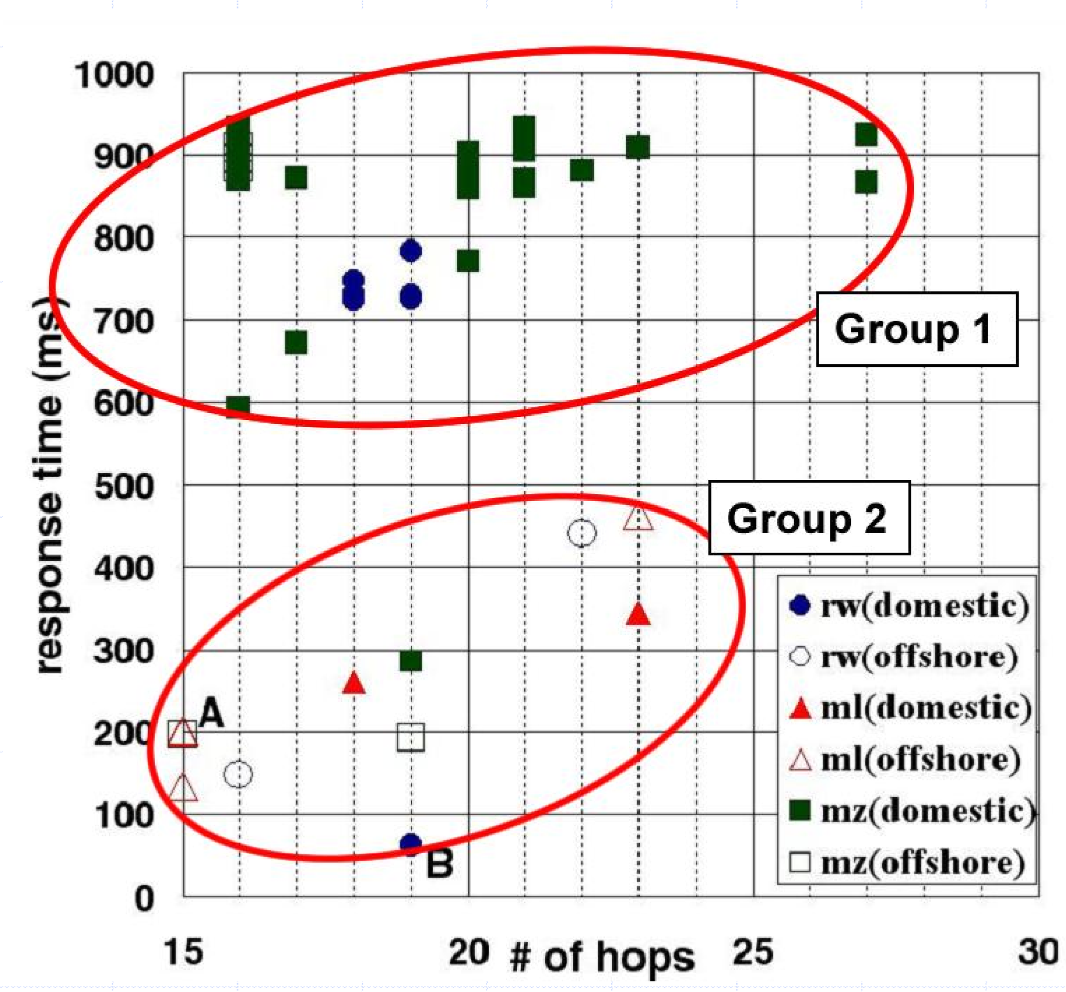


Figure 3: Response time and number of hops from Japan to surveyed servers under African ccTLDs

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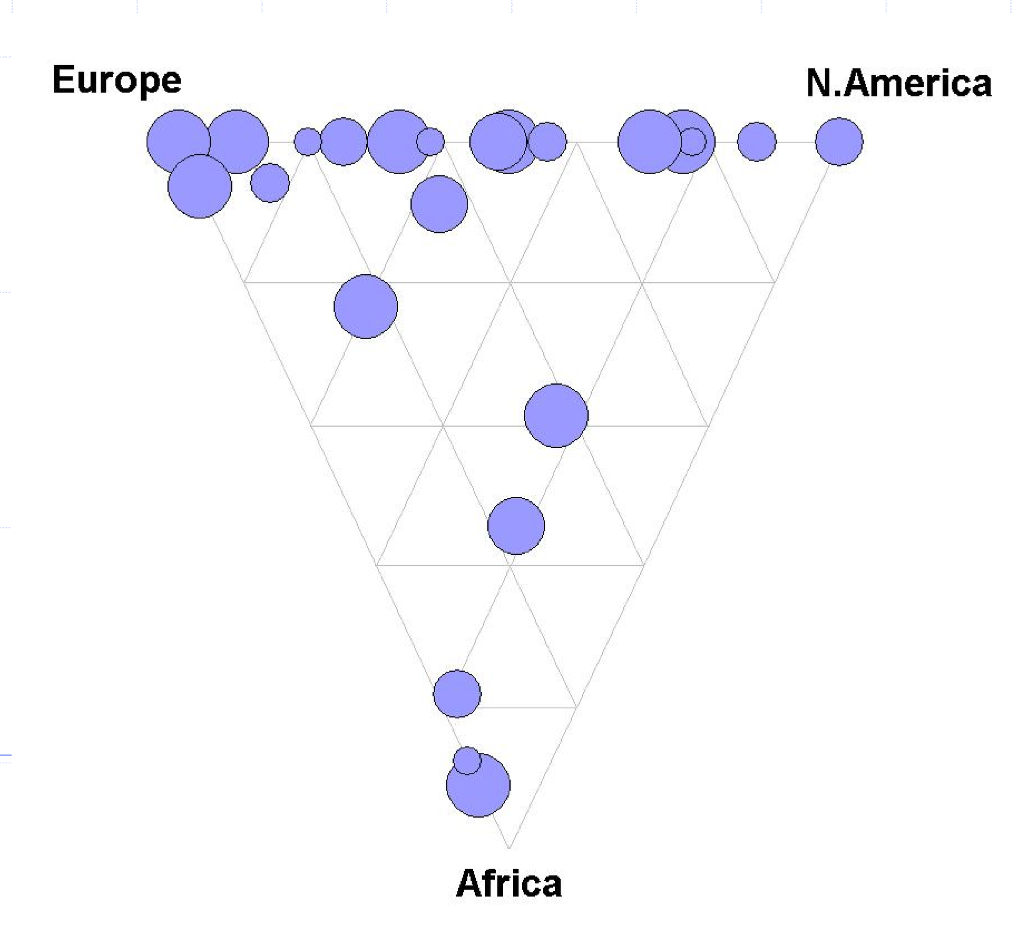

Figure 4: Geographic centroids of surveyed servers under African ccTLDs

Where are offshore servers located? In order to give abroad overview, Figure 4 shows "geographic centroids" of server locations in each ccTLD in a triangle whose points are Africa (partially including Asian or Oceanian countries),Europe, and North America. The size of a circle in the figure represents the number of sample servers in each ccTLD.

We had expected that the choice between Europe and North America for the location of a server would be influenced by specific factors, such as historical relations and language.

→But in reality, no clear preferences have been identified, except that, as a whole, there is greater reliance on Europe or U.S.

In terms of the ranking of non-African host countries, the highest is the U.S. (545), followed by the Netherlands (511).

Simulation with Heavy Traffic

The response time to the target sites measured by traceroute command shows the network performance only in case of minimum traffic (packet size of traceroute command is only 44 bytes). Response time in real application should be slower depending on traffic load.

In order to estimate more realistic response time, a network simulator OPNET Modeler® is configured. Network topology and parameters of the simulator are set based upon the number of hops and routing information found in the case of Rwanda and response time for heavy browsing (1Mbps) is simulated. The result is shown in Figure 5. The result shows that in case of heavy browsing, response time to Rwanda would become more than twice slower.

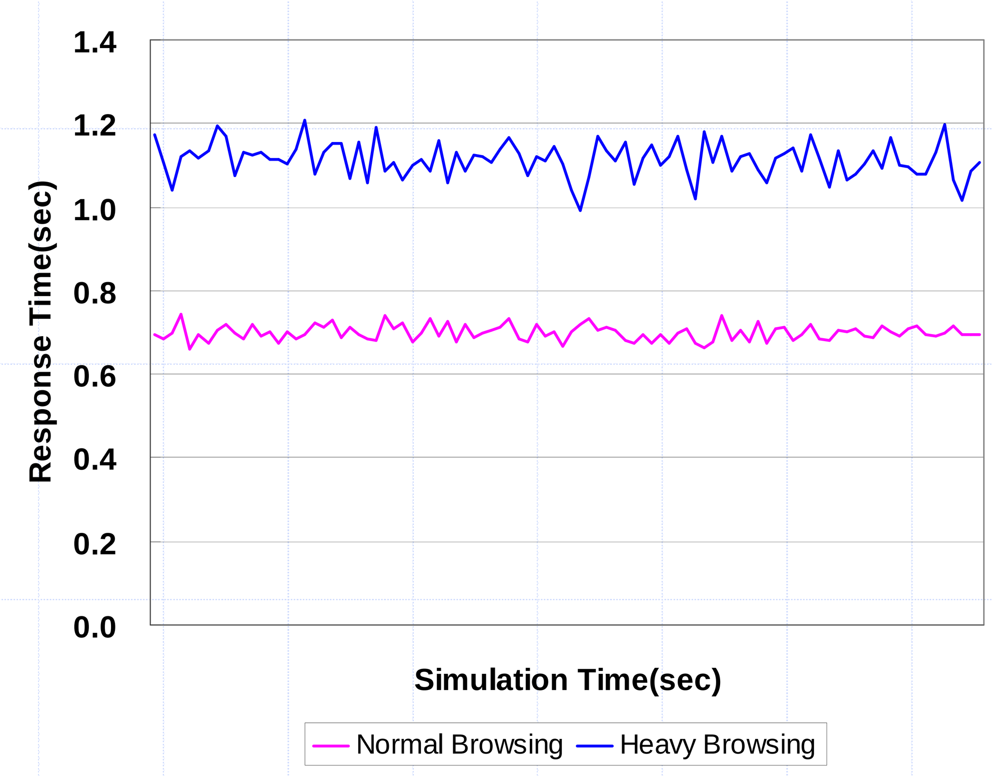

Figure 5: Result of network simulation between Rwanda and Japan

Conclusion
Offshore servers - A significant aspect of Digital Divide in Africa

Likely background

1. The delay in upgrading of domestic telecommunication networks.
2. The shortage of skilled server/network maintenance personnel.
3. The need to get foreign country by reselling domain name.

Problems of offshore servers.

1. Offshore servers reduce the speed of access to these servers from the population within the country.
2. Offshore servers heighten the risk that domestic laws and regulations cannot be applied to management of there servers.
3. If offshore servers keep growing, it may discourage the development of domestic telecommunication network and disturb the growth of technical skills in the country (vicious cycle).

Questions arising.

Who owns country domains?
To what extent reselling and re-delegation of domain management be allowed?

Domain name should be considered as one of the most important resources for the development of national network infrastructure.

High percentage of offshore servers constitute a significant aspect of the digital divide problem in Africa.

Acknowledgements

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Simulation with heavy traffic has been done using OPNET Modeler®.

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