

Device for Data Management to Enhance Cellular Efficiency in Rural Areas

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Introduction

This document describes the working prototype and proposes a framework which can be implemented to make a device for data management to enhance cellular efficiency in rural areas.

The issue of network outage is a prevailing phenomenon for villages with unstable internet connectivity in India. It can be caused due to natural disasters, power failure, hardware upgradation, regular maintenance, or due to several other unpredictable reasons.

With e-governance initiatives and new electronic services being designed specifically for Indian villages, it is essential that internet connectivity should be present for most of the time.

Natural disasters and other unpredictable issues cannot be anticipated and dealt with. With the prototype and proposed framework, power failure at the network gateway can be avoided for a limited amount of time and hardware upgradation and regular maintenance tasks will not result into network downtime.

Possible Solutions

To overcome network outage, several options have been explored by us, which include:

- Proxy Auto-Config (PAC)
- Reverse Proxy Server
- Web Cache Communication Protocol (WCCP)
- Transparent Proxy Server with Cache as Network Gateway

Proxy Auto-Config is a method which is used to automatically assign the IP address and port of the Proxy server to web browsers and user agents. This method is invoked by using a JavaScript function within websites. It also uses the Web Proxy Autodiscovery Protocol (WPAD). The drawback of using this method is that it is dependent on the website and the server needs to be configured to cache webpages.

A Reverse Proxy Server retrieves resources on behalf of a client from one or more servers. It typically sits behind the firewall in a private network and directs client requests to the appropriate backend server. This server is to be used at a hosting datacenter and thus, it does not fulfill the requirements of this project.

Web Cache Communication Protocol (WCCP) is a Cisco proprietary content-routing protocol which provides a mechanism to redirect traffic flow transparently from routers and switches to proxy servers in real time. This protocol fulfills the requirements but as it is vendor specific, the implementation cannot be generalized to any available hardware.

To overcome power failure, a redundant Power Supply Unit (PSU) can be added to the device.

For critical applications, a further failover mechanism can be deployed with an Uninterrupted Power Supply (UPS) device.

Working Prototype

We have implemented a caching proxy server in Java which can cache static webpages with HTTP objects (without images) which can be served to the users when requested.

The code utilizes the java.net package for Socket programming and data structures like ArrayList and HashMap to maintain the cache of websites and the record of cached websites respectively.

Screenshots:

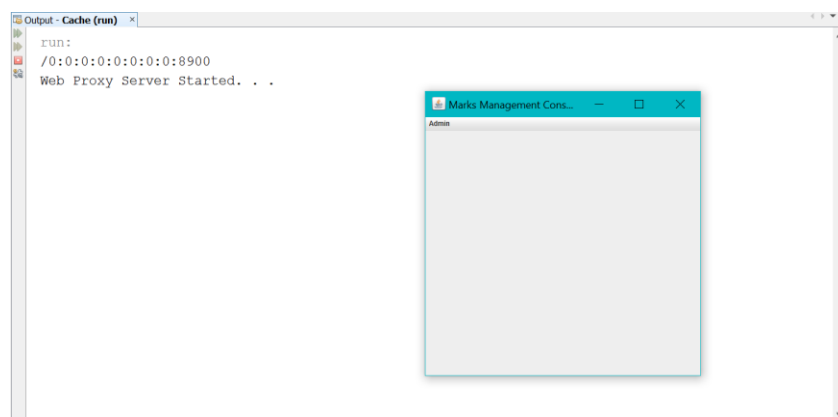


Fig. 1: Server Started, Cache Empty

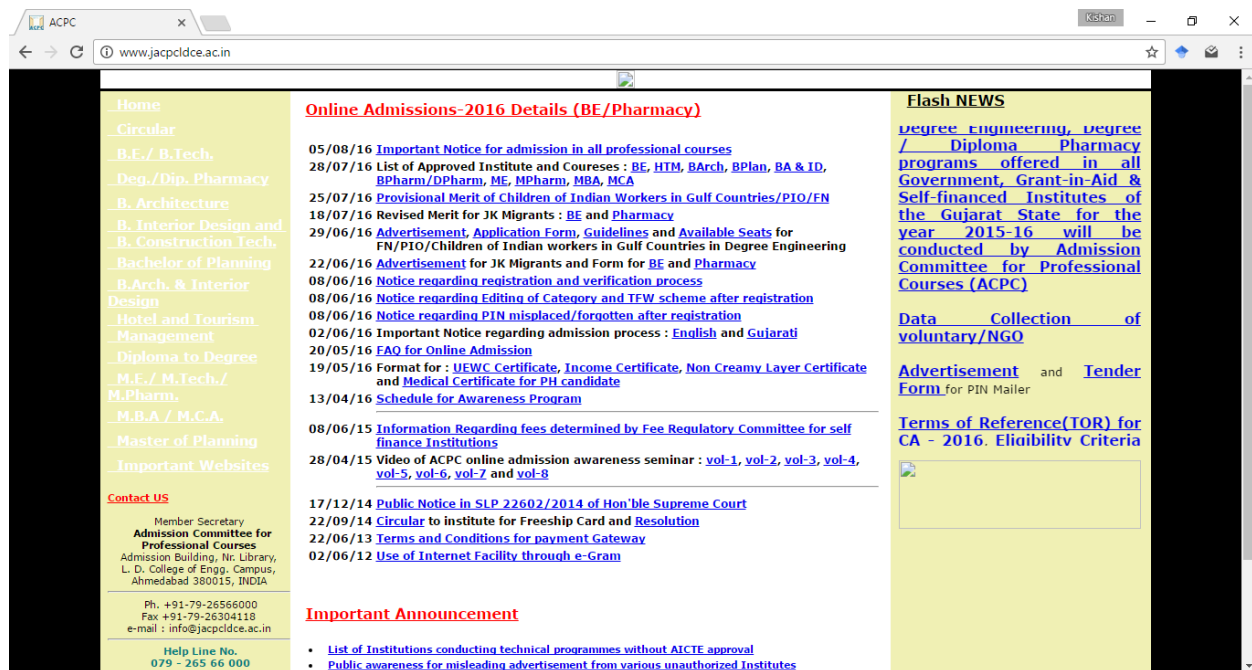


Fig. 2: Demo website opened in client

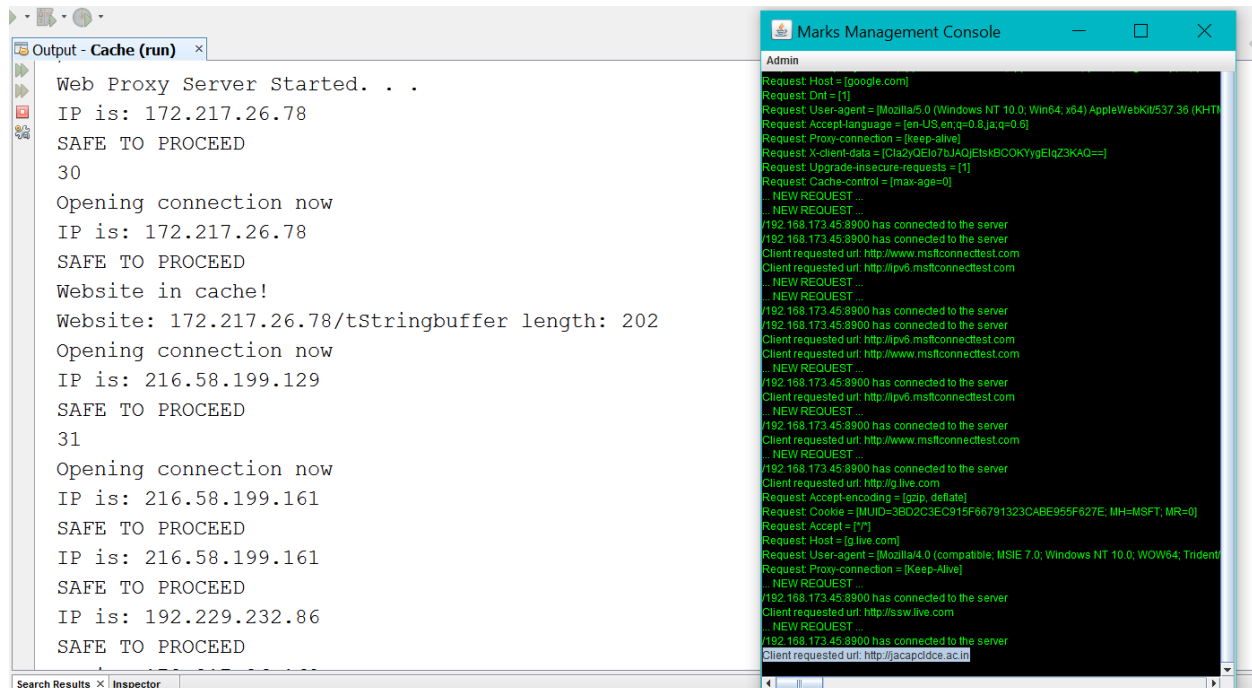


Fig. 3: Server logs the client request

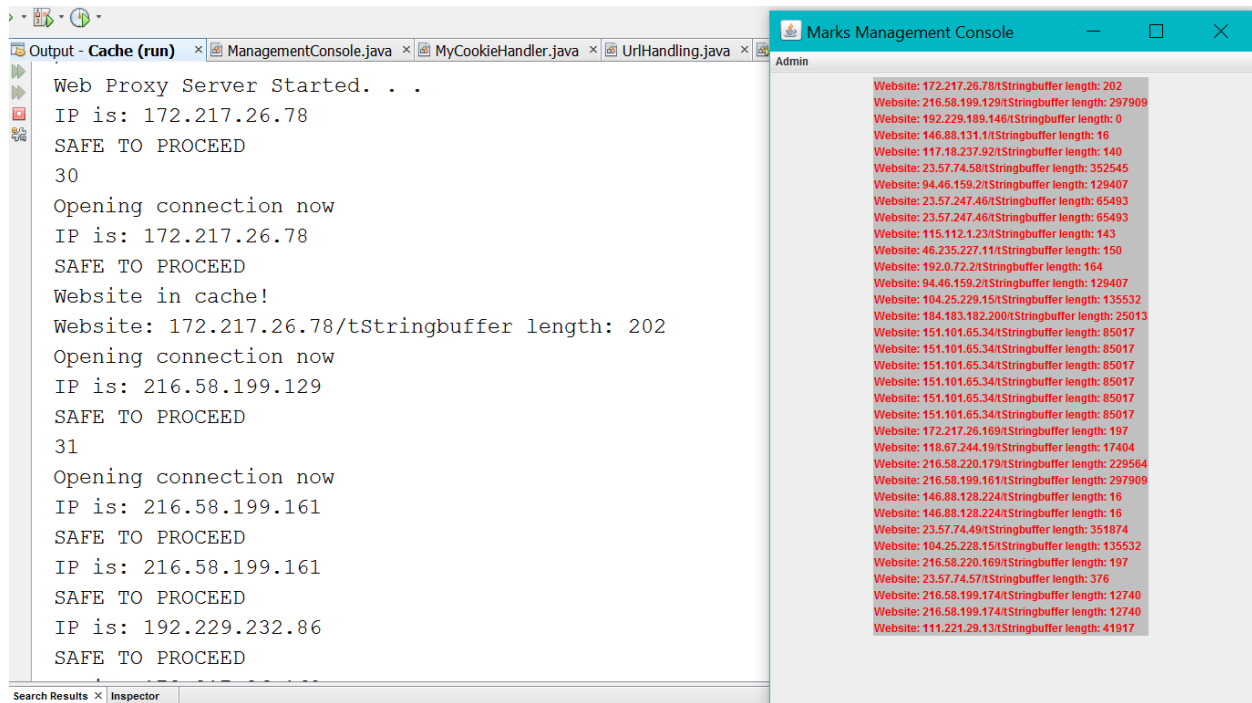


Fig. 4: Cached website list

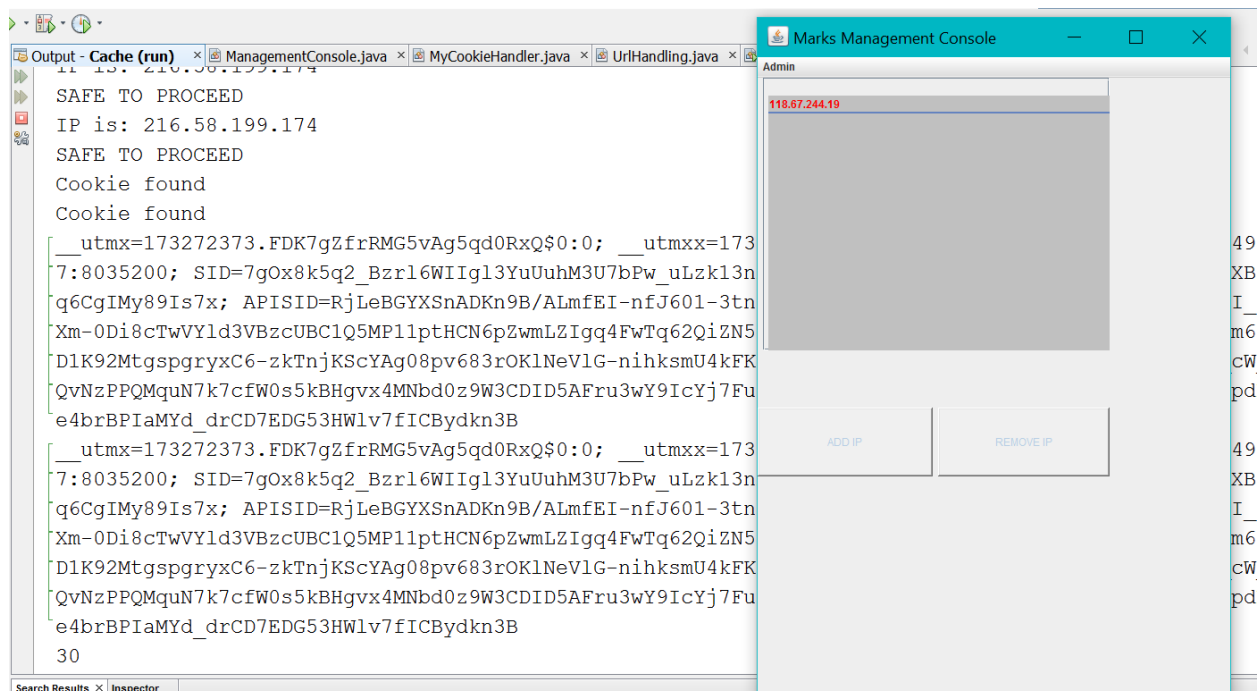


Fig. 5: Block List at Server

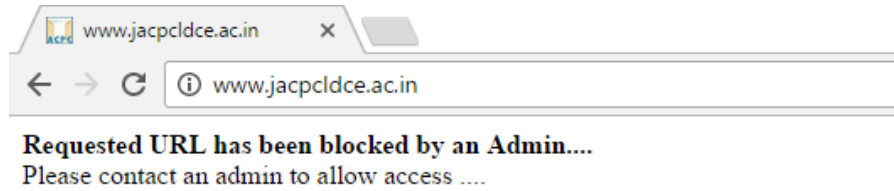


Fig. 6: Server response to Client when blocked website is requested

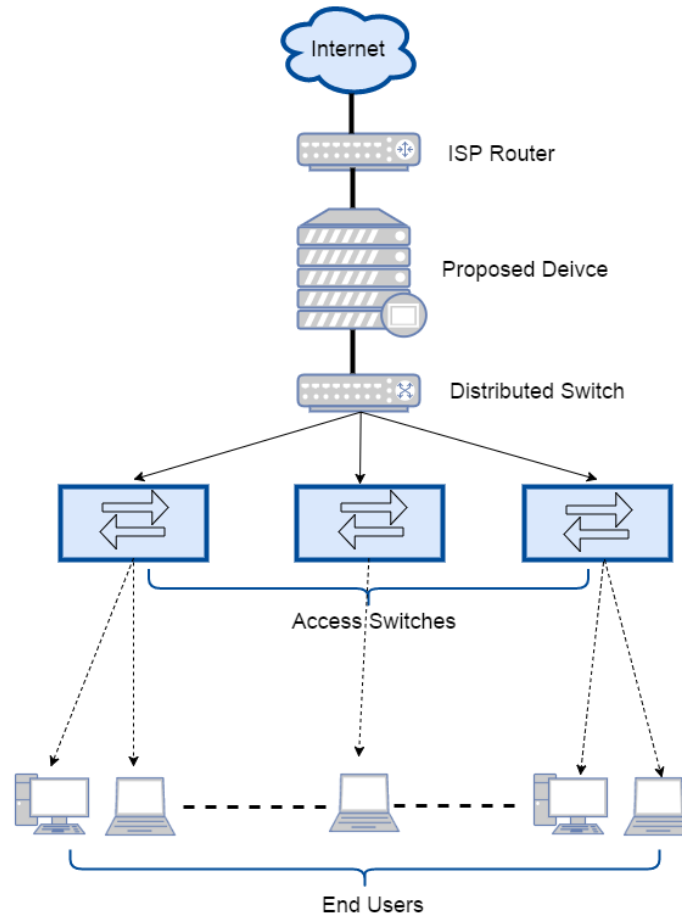
Limitations:

- We have to manually configure the proxy settings (IP Address and TCP Port) in each client.
- Only HTTP websites can be accessed as HTTPS requires end-to-end encryption which is not possible with this Java program.

Proposed Framework

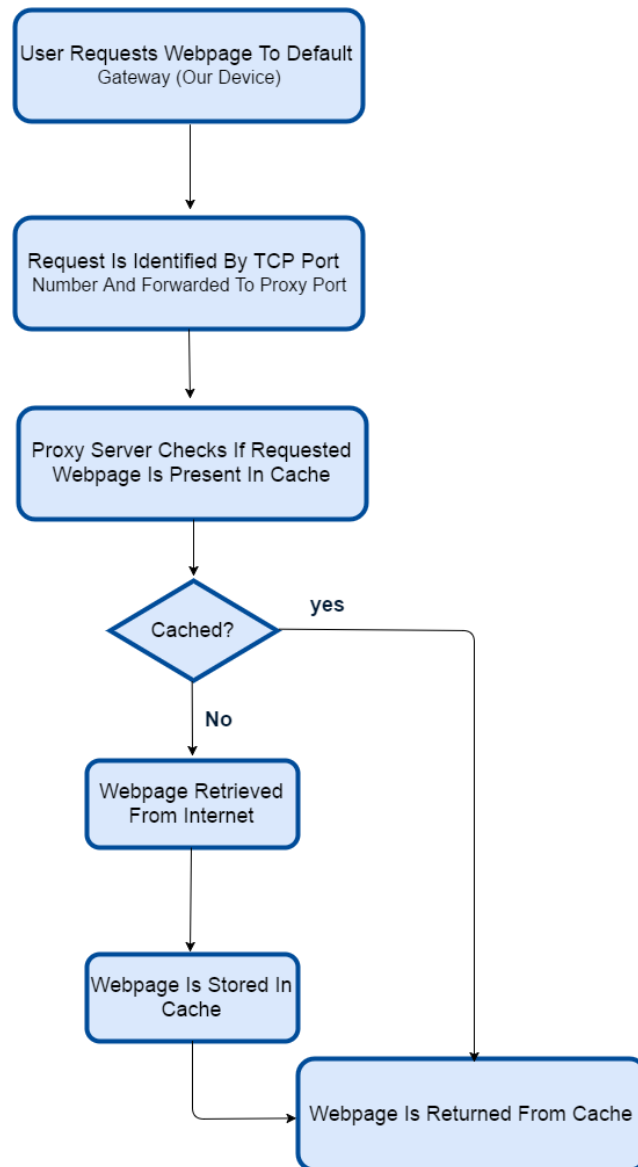
To overcome the limitations of the above tested working prototype, we propose a framework that can be implemented on low-configuration hardware like a Raspberry Pi or a thin client. This model required no configuration on any client and thus, the transition process can be made seamless.

Our proposed device will be connected to the ISP router at the local port and it will be running a DHCP server and an open source Proxy Cache server (Squid).



When an end user connects to the rural network, the host requests for an IP to the DHCP server. An IP address is assigned with the appropriate Subnet Mask and Default Gateway (Our device).

The device is a Linux machine which has been configured as a firewall, DHCP Server, and Proxy Cache server. All HTTP requests are forwarded to the Proxy server port by an *iptables* forwarding rule.



When there is network failure from the ISP end, the Proxy server can still serve webpages to clients stored in the cache. Certain government informational websites will be cached periodically to ensure the latest available copy in case of network failure.

Acknowledgement

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We thank them for giving us this opportunity to work on a project with a realistic, tangible outcome and can be used for the betterment of the quality of life of many people.

References

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- ii. <https://www.nginx.com/resources/glossary/reverse-proxy-server/>
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