Investigation of Availability of Access Points based on Embedded Systems

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Introduction

Purpose: to disseminate methods and measures for the use of wireless networks for the business, scientific, and educational sectors.

- Demonstration of the actual capabilities of wireless systems.
- Functional analysis of technical properties based on various operating systems, hardware, and services.
This work solves the problem of “last mile.”
Taking into account the specifics of wireless
device-based network devices, we emphasize
the importance of ensuring a stable connection
of devices, protecting their work from
unauthorized access and preventing and
minimizing interference to normal functioning.

Using minicomputers allows you to save a lot
of resources. Such systems require a minimum
of power, network resources, flexible setup, etc.
We have reviewed the problems people experience while implementing different projects on Embedded systems. The general topics are:

• Security measures\textsuperscript{2,3}
• Efficiency of limited executing resources\textsuperscript{4}
• Scalability\textsuperscript{5}

\textsuperscript{2,3,4,5} – refer to sources in work
Previous Work

One of the good examples is the use of the platform as a network access point with the use of a mini screen, which can display the necessary monitoring functions. The access point based on the Raspbian OS and the screen was programmed on bash\(^6\).

\(^6\) – refer to source in work
The RPi computers are still the most widely used devices in many projects and have the largest community support. Moreover, they support a great deal of different OS (Fig.1). These are main reasons why we choose the latest version of RPi 3 B+.

The full tree you can see in Fig. 1 in the paper.
Discussion

There is another board, for instance, Banana Pi, Arduino, ODROID, ESP32, etc. Comparative analysis of boards is presented in Table I.

For more details see Table I in work.
Main purpose and requirements contain:

- Simple code and widely used language
- Ability to perform on Windows
- Operating at full load on limited resources
- Ability to collect results

Software architecture shown on Fig. 2.
Fig. 2. Software functional scheme
The board have many various OS’s, services and modules, which supported like a standard Unix system. So we choose most usual OS and usb wi-fi stick:

- Board – RPi 3B+ (2.4/5 GHz)
- OS – Raspbian Lite OS and OpenWRT
- Storage – MicroSD UHS-I
- Wireless chip – TL-WN722N v.1(AR9271) and CYW43455
- Services: dnsmasq, hostapd, vsftpd and others

7 – refer to source in work
Practical Experience

A file size of 30 MB has been selected, for complete download tracking for all clients.

Wi-fi Access point was placed in the center of 15 machines (classroom). The 1 of machines was chosen as server. It is started and configured simply by cmd.

All clients were connected to access point and then to server machine, configured to waiting command to start.

On the server, while clients connecting, the info was shown about all connected clients.

When all needed client connected, on the server we push start and all clients get command to download file on ftp-access point simultaneously.

On the end, all clients sent report to server in txt format.
Practical Experience

In addition, we can compare the diagram of speed tests on different wireless cards and OS’s in Fig. 4. And experimental hardware in Fig. 5.

Fig. 4. Speed test with different operating systems and cards

Fig. 5. Experimental hardware
Having built a polynomial trend line (see Fig. 6), it is easy to see that the relative decrease in the transmission rate for both bands is almost the same and is about three times (the absolute speed drop for 2.4 GHz frequency band was 0.04 MB/s, and for 5 GHz was 0.18 MB/s).

We got the maximum speed value on the WRT platform with maximum speed of 600 kb/s and the lowest on the RPi external platform 200 kb/s. Other measurements failed due to unstable data transfer. The full results were shown in Table II.

Fig. 6. Data transmission test on different frequencies
CONCLUSION AND FUTURE WORK

This work outlines and justifies the current problems of connecting end devices in wireless networks. Available capabilities of embedded systems can support connections from several to several dozen, but it is necessary to carefully select the wireless adapters offered by manufacturers on embedded platforms or develop solutions using additional adapters, antennas, supported encryption technologies, and data transfer protocols.

Table II. Average Research Results

<table>
<thead>
<tr>
<th>Clients</th>
<th>Platform</th>
<th>Average speed, kb/s</th>
<th>t-distribution</th>
<th>Pearson coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>RPi external</td>
<td>262.6±7.0</td>
<td>2.045</td>
<td>-0.99896</td>
</tr>
<tr>
<td>7</td>
<td>RPi internal</td>
<td>309.4±1.8</td>
<td>2.045</td>
<td>-0.99973</td>
</tr>
<tr>
<td>7</td>
<td>WRT external</td>
<td>444.9±54.1</td>
<td>2.045</td>
<td>-0.93667</td>
</tr>
<tr>
<td>14</td>
<td>RPi internal</td>
<td>131.6±0.3</td>
<td>1.994</td>
<td>-0.99997</td>
</tr>
</tbody>
</table>
CONCLUSION AND FUTURE WORK (continue)

- The statistics indicate possible errors in the operation of the services.
- The compatibility of network controllers (chips) and the operation of network services OS, although it is quite broad, however, it cannot guarantee its full performance.

- In next work, we planing to check a data exchange service, database or web server with a certain level of security. And conducting a penetration test, checking the stability of the security measures described above and a general assessment of the vulnerabilities of smart systems.
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