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Software Development process for Oscilloscopes: A survey

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Abstract: Software processes for developing embedded devices is a challenge as devices tend to be long lasting and need regular software updates to sustain in modern world, one such electronic device is Oscilloscope which is used and precision evaluation and testing other electronic instruments. Software plays a vital role in such devices as managing large subsystems can pose a challenge, this paper focuses on software development process by taking a architecture such as SV methodology that resembles some of the existing frameworks of C which provides a better understanding for developers to design and maintain software. Database for embedded systems is less known but provides essential functionality for storage of subsystems. To design a system having a top-level design is essential to understand the instrument database and transactions happening in an oscilloscope. Understanding a product by taking Oscilloscope and focusing the software aspects which directly affects user experience is essential. Linux based systems is recommended instead of bare metal as it has existing essential features which can be used and developer need not implement all basic features from start.

Keywords: Oscilloscopes, Network file System, Instrument database, style, Transaction Manager

I. INTRODUCTION

Software development process has been debated over a long period, whether to follow a single practice that gives a good output the final decision was that a single practice may or may not apply for a certain software development, depending upon the product, team the decision should be taken which best fits and checks all boxes. An Oscilloscope is an electronic device that takes input as electronic signal and display graphically so that the user can view, analyse and debug the electronic signal. Any electronic device needs to be tested and debugged which can be done by analysing the voltage and current passing through the circuit. Embedded devices are known for their custom Architecture and can vary in complexity depending upon the subsystems required for the system. Designing subsystems depend upon the functionality like Oscilloscopes contains AFG, RF, Mask etc... which are algorithms designed for specific use and are contained as a module hence these modules are to be contained and use as UI elements by designing action block elements.

Oscilloscope provides solutions in areas such as Automotive, Medical, `Military, Education etc. The Device primarily is used for test and measurement and find application in many areas such as 3D Sensing and Image Characterization, EMI/EMC Testing, High Speed Serial Communications, Material Science and Engineering, Power Efficiency and Wired Communications. Some of the industries such as Advanced Research, Automotive Education and Teaching Labs, Military and Government require Oscilloscopes. The device has a front panel which acts as input/output user has to click on icon to perform any action, which include getting statistics of the waveform from the input through channels, comparing waveforms from other sources and many other measurement settings. Oscilloscopes have applications in Automotives specifically in EV's have a lot of scope which includes troubleshooting and debugging. The components involved in an EV communicate each other hence an Oscilloscope has a wide range of protocols such as I2C, CAN and many such protocols which are required by the components of EV hence it requires testing and debugging of components that use these protocols by using Decoders and display it on the screen.

In this competitive market existing products need to be enhanced to meet customer needs and implement features by taking customer feedback. Any diagnostic to be performed to understand and debug any electrical instrument needs oscilloscopes and to take better advantage of the algorithms of the device a clean UI needs to be implemented. User experience is top priority on building any product hence any small lag and screen mistouch can be recognized easily and should be dealt appropriately, any wrong selection of feature in a middle of a process can be annoying as the user needs to start the process of diagnostic/measurement from the beginning. Save/Recall feature gives flexibility to the users to perform trial and error procedure or any un-planned activity with the front panel. Implementing new feature puts extra computation on the device and due to the limited resources and power any implementation should be optimized by performing quality checks and stress testing. Security aspect of embedded system should be strictly checked as c/c++ language which is most widely used

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for these devices are vulnerable to memory leak [5] hence can be exploited and cause denial of service. The attack can also be launched as attack vectors through internet as oscilloscope can have the option to be used via remotely malicious TCP/IP packets can be injected to allow remote code execution and basically hijack the whole system or even enter into the main network of the organization hence any debugging, feature enhancement done needs regular checkups for memory leaks and pen testing to be performed.

II. LITERATURE SURVEY

The need for complex gadgets is increasing with an increase with the feature requirement Linux kernel is a valuable asset from software perspective as it provides a wide range of compatibilities [1] along with a good programming platform. It also provides an upper hand when it comes with kernel-to-kernel code interaction made possible by PREEMPT_RT patch. Security should always be considered for electronic devices as it might contain sensitive data in case like a device getting connected, mounted to share access of files, it's always a good practice to test all the possible vulnerabilities some possible methods using Linux to strengthen security is mentioned in [2], such as, secure repositories, compatibility layer of Linux Kernel, password management, file accessibility and many such other methods. Linux Kernel in embedded system provides [3], various modules such as memory management which becomes crucial for faster operations as it contains limited memory optimization becomes essential and other such modules are Inter-process communication, Network file systems, and device drivers. Software Aging [4] is an important concept for embedded systems as the device may or may not support continuous software updates hence should rely on an optimized software as many applications have been reported hence the need to consider software aging. Model based testing [6] is also widely adopted when test – case or use – case and be formed for testing this can be automated using combination of stress commands but that may not contain all logical scenarios.

There are backdoors where a particular tech stack may contain a vulnerability and expose the system, one such probability for exposure was discussed in [7] where the executable or the firmware which is the end compiled file uses libraries which can be licensed or open sourced hence using this can be done via dynamic linking and via run-time but the end result showed that the attacker may lack the motivation to perform manual analysis. Oscilloscope can I have logs to store the device state and crash analysis this can pose a security issue as the operating system can be vulnerable, this detailed analysis is performed in [8], from requirements to methods utilized for logging and storing the data in applications can be subjected to attacks hence the data to be stored should be examined according to the confidentiality and data can be virtualized in Oscilloscope where many organizations provide data security. Oscilloscopes can be connected to wi-fi at share data and sync data among other devices this can have vulnerabilities to be exploited this analysis is done in [9] , by Linux operating system these attacks can cause denial of service and even hack full device by taking control these attack are targeting through the data and physical layer , the data can disclose the vulnerability of the testing device which can cause millions of loss to the organization.

III. PROPOSED SYSTEM

Embedded systems provide developer the option to design the architecture as they like and design the architecture according to the subsystems hence provides opportunity to optimize the whole system from scratch. The Oscilloscope is one such device where architecture is designed in such a way that irrespective of the algorithm implemented for the actual functionality the way the whole system communicate can be designed on the top of it by using simple programming concepts. Linux operating system provides good platform to build software for Oscilloscopes and using c/c++ provides performance due to its memory usage advantage as the device has a limited memory. The application communicates with both operating system and the framework to communicate with the drivers, Linux has an added advantage as the hardware devices are written as normal files which is easier to interact. Software development usually starts with planning, information gathering, requirements, risk analysis and most importantly the necessity. Then starts the designing architecture which best fits the subsystems considering an Oscilloscope it has subsystems such as bus, math, measurements, etc. For Existing systems that requires changes such as enhancements the same developer might not be working hence understanding the architectures becomes an important task as understanding subsystems can pose challenges.

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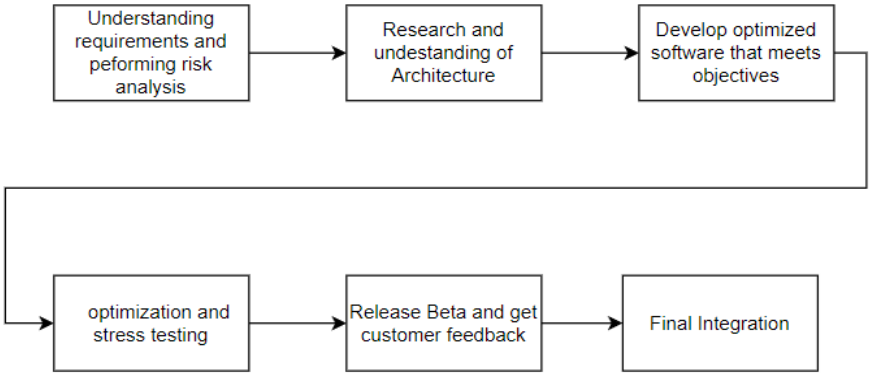

Figure 2.1 Methodology

Then starts the designing architecture which best fits the subsystems considering an Oscilloscope it has subsystems such as bus, math, measurements, etc.

A. Instrument Database

Consider Instrument Database (IDB) type of Architecture for a system, here every subsystem including its settings in any form such as assigning value, check box, selection and many others are considered as IDB, they can have a common signature but not limited to the number of attributes. Hence any of these settings can be considered as an action or a transaction in terms of database context these allow to control and manage subsystems and any other successive subsystems that get triggered as a chain reaction, this approach resolves internal-conflict, provides standard flow hence easier to debug or add new features. All the triggers from IDB are resolved in Transaction Manager which serves as a common place for subsystems, processes happening in real-time for data exchange as shown in the figure. This design can be implemented by a simple C program by following rules of database such as considering a process as a transaction only when it commits which is a constitutes as the error/exception handling mechanism. Transaction manager not only glues subsystems but also forms the core of software for allocating memory, displaying error message hence any algorithm developed in this needs to be optimized.

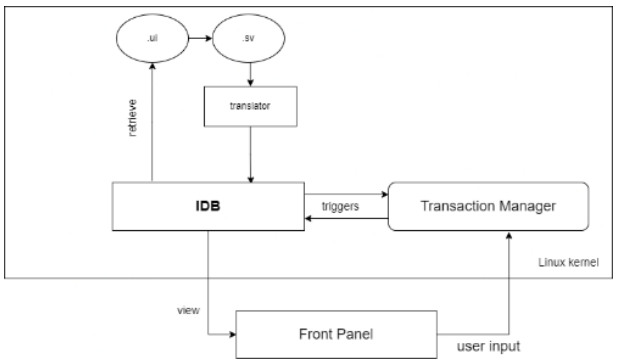

Figure 2.2 General Architecture

The next phase for developing software for an Oscilloscope needs a server to start with but the user has the option to do it locally which is not recommended, this requires setting up SSH and performing NFS booo the device this allows for remote execution and booting the device with firmware instead of doing it manually. Enabling the above system needs a methodology that combines all the things together from UI to back-end one such approach can be SV methodology. SV methodology can be considered a framework for embedded systems for UI and back-end, the Interface can be defined in .ui files where icons can be defined and referenced to sv files that come under SV framework, both files are linked using a SV translator that becomes one C file, the next step remains the same as that of a normal C file compilation. SV program resembles the syntax of C but has additional capabilities to aid UI actions. The UI elements should be trigger to perform some action these actions can be termed as Action block list because there might be a series of subsystem calls, this can be done separately for each subsystem it is a linked list of dynamic guarded actions associated with an action

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block, and which has as members those actions belonging to the block that are ready to run. All the data storage can be done using xml files as there is not much data storing process required for oscilloscopes.

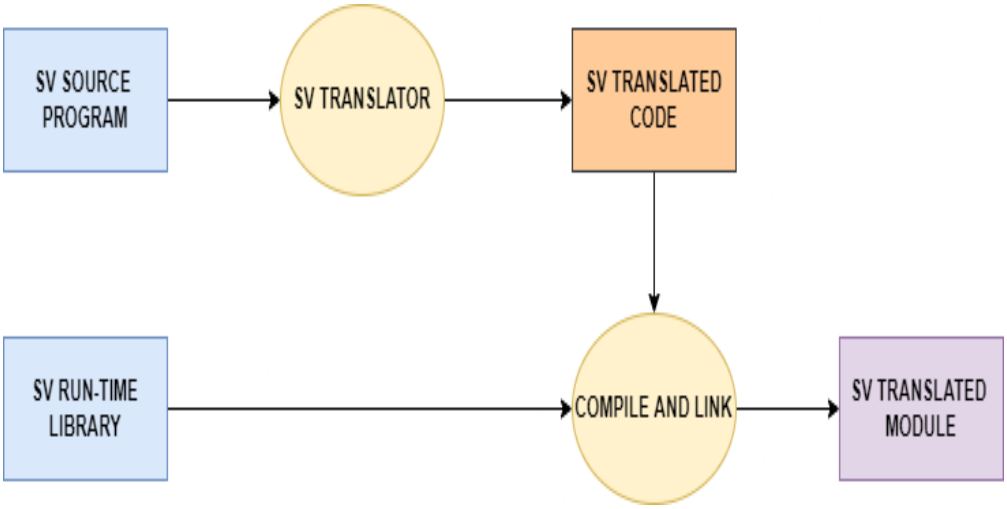

Figure 2.3 SV Methodology

The next phase is testing but usually developers perform first layer of testing such as unit testing for extensive testing a team as shown in figure 2.3 after compilation and linking, modules are formed which again after linking forms a single output file hence it allows the developer to add new features according to the modules and is easier to debug. Performing stress testing is crucial for any system especially embedded devices to determine its performance and long usage.

IV. ADVANTAGE OF LINUX BASED SYSTEMS

There are several reasons why many developers prefer Linux based environment for development is because of no restrictions which the other platforms impose hence provides a freedom for experimentation with other reasons such as large community (open source) and driver programming support.

1. **Connectivity support:** Developing a device as a bare- metal does not contain any connectivity features like Wi-Fi or internet connection or USB, Linux enables the device to send data packets for communication.
2. **Security:** Linux is not a fully shielded OS but it provides basic security hence any backdoors or bugs can be identified early due to the large community one of the perks for being open source.
3. **In-expensive:** Operating systems such as windows needs licensing to fully use its services for business related activities while Linux based OS have open-source applications for almost all of the services provided by windows.
4. **Widespread:** Being widely known can come as a perk as the customer will tend more towards Linux based system rather than some unknown operating system.
5. **Customization:** Having an operating system customizable can lower the restrictions on the developer and architect to custom design their software rather than build software that fits into the OS.

V. CONCLUSION

The above approach gives idea for developer to start his Software development process for Oscilloscopes or systems that contain subsystems developed on Linux kernel. Usually c/c++ or c# is used as programming language, this paper explains the necessity and an approach involved to develop and maintain the software. Every system designed needs enhancements due to many reasons such as extra features, improve user experiences these require understanding of Architecture and following practices that best aid in debugging. This paper presents a methodology which helps the user to design their own Architecture for embedded systems where a developer may or may not be aware of the actual implementation of the algorithm for the subsystem regardless the developer needs an approach to best design to future proof the system allowing minimal changes to modify the software. A study can be performed to identify what users require and how they like a device as a touch screen device the user should feel the smoothness while interacting with device and should not be ambiguous while performing some action, Oscilloscopes usually requires a manual to understand all the subsystem this can be minimized by having an Artificial Intelligent system that understands users and provides analytics for the user to get critical information. Developer can get an idea from SV methodology and inspire to develop a similar mechanism to develop a software for oscilloscopes.

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REFERENCES

[1] Federico Reghenzani , Giuseppe Massari , William Fornaciari "The Real-Time Linux Kernel: A Survey on PREEMPT_RT" ACM Computing SurveysVolume 52,Issue 1,January 2020 Article No.: 18pp 1–36
[2] Matthew R. Yaswinski, Md Minhaz Chowdhury, Mike Jochen "Linux Security : A Survey" 2019 IEEE International Conference on Electro Information Technology (EIT)
[3] Chun-yue Bi, Yun-peng Liu, Ren-fang Wang "Research of Key Technologies for Embedded Linux Based" in 2020 International Conference on Computer Application and System Modeling (ICCASM 2020).
[4] Domenico Cotroneo, Roberto Natella, Roberto Pietrantuono, Stefano Russo "Software Aging Analysis of the Linux Operating System" published in 2020 IEEE 21st International Symposium on Software Reliability Engineering..
[5] Thomas Nyman ,Ghada Dessouky, Shaza Zeitouni, Aaro Lehikoinen, Andrew Paverd, N. Asokan, Ahmad-Reza Sadeghi "HardScope: Hardening Embedded Systems Against Data-Oriented Attacks" published in 2019 56th ACM/IEEE Design Automation Conference (DAC)
[6] Vahid Garousi, Michael Felderer, Çağrı Murat Karapıçak, Uğur Yılmaz "What We Know about Testing Embedded Software" published in IEEE 2018 Volume :35 issue :4 .
[7] Emanuele Cozzi; Mariano Graziano; Yanick Fratantonio; Davide Balzarotti "Understanding Linux Malware" published in 2018 IEEE Symposium on Security and Privacy
[8] Lei Zeng , Yang Xiao, Hui Chen , Bo Sun and Wenlin Han "Computer operating system logging and security issues: a survey" Published on 20 October 2016 in Wiley Online Library (wileyonlinelibrary.com)
[9] Ana Yacchirena, Darwin Alulema, Darwin Aguilar, Derlin Morocho "Analysis of Attack and Protection Systems in Wi-Fi Wireless Networks under The Linux Operating System" published in 2016 IEEE Xplore