Extracted from:

#### Build a Binary Clock with Elixir and Nerves

Use Layering to Produce Better Embedded Systems

This PDF file contains pages extracted from *Build a Binary Clock with Elixir and Nerves*, published by the Pragmatic Bookshelf. For more information or to purchase a paperback or PDF copy, please visit http://www.pragprog.com.

Note: This extract contains some colored text (particularly in code listing). This is available only in online versions of the books. The printed versions are black and white. Pagination might vary between the online and printed versions; the content is otherwise identical.

Copyright © 2022 The Pragmatic Programmers, LLC.

All rights reserved.

No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form, or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior consent of the publisher.

The Pragmatic Bookshelf

Raleigh, North Carolina

Pragmatic Programmers

## Build a Binary Clock with Elixir and Nerves

Use Layering to Produce Better Embedded Systems

> Frank Hunleth and Bruce A. Tate edited by Jacquelyn Carter

# Build a Binary Clock with Elixir and Nerves

Use Layering to Produce Better Embedded Systems

Frank Hunleth Bruce A. Tate

The Pragmatic Bookshelf

Raleigh, North Carolina



Many of the designations used by manufacturers and sellers to distinguish their products are claimed as trademarks. Where those designations appear in this book, and The Pragmatic Programmers, LLC was aware of a trademark claim, the designations have been printed in initial capital letters or in all capitals. The Pragmatic Starter Kit, The Pragmatic Programmer, Pragmatic Programming, Pragmatic Bookshelf, PragProg and the linking *g* device are trademarks of The Pragmatic Programmers, LLC.

Every precaution was taken in the preparation of this book. However, the publisher assumes no responsibility for errors or omissions, or for damages that may result from the use of information (including program listings) contained herein.

For our complete catalog of hands-on, practical, and Pragmatic content for software developers, please visit <a href="https://pragprog.com">https://pragprog.com</a>.

The team that produced this book includes:

CEO: Dave Rankin COO: Janet Furlow Managing Editor: Tammy Coron Development Editor: Jacquelyn Carter Copy Editor: L. Sakhi MacMillan Layout: Gilson Graphics Founders: Andy Hunt and Dave Thomas

For sales, volume licensing, and support, please contact support@pragprog.com.

For international rights, please contact rights@pragprog.com.

Copyright © 2022 The Pragmatic Programmers, LLC.

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form, or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior consent of the publisher.

ISBN-13: 978-1-68050-923-6 Encoded using the finest acid-free high-entropy binary digits. Book version: P1.0—August 2022

## Acknowledgments

Though this cover prominently highlights two authors like a couple of shining LEDs, the real story behind the story is one of a much greater team. In these short paragraphs, we'll try to thank those who made this book possible.

First, we'd like to thank the wonderful staff at The Pragmatic Bookshelf for all of their help and support. The staff has always provided unwavering support to Elixir. We offer special thanks to our friend and editor Jackie Carter who tirelessly works to get more out of us. She's our friend and our ally. Thanks for being there.

José Valim, you have created something lasting and remarkable. Your creation of Elixir and stewardship of the community has had an incalculable impact on all of our careers, and we are all profoundly grateful for what you do to continue to push the language, ecosystem, and infrastructure forward. Your insightful leadership with LiveBook had a direct impact on this book.

We also thank Jonatan Kłosko for your creation of LiveBook. It gave us a story to tell even when supply problems were crushing the rest of this book.

Of course, we thank our reviewers Denver Smith, Kim Shrier, Masatoshi Nishiguchi, Mike Waud, and Jason Johnson. Reviewing a book with hardware has an extra level of commitment that most books don't. Thanks for building out the project and being patient with the words that were sometimes too expert or too basic. You helped form a bridge between this team of authors.

Thanks go also to the Nerves Core Team of Jon Carstens, Connor Rigby, and Masatoshi Nishiguchi. They have shown incredible flexibility and judgement. Nerves wouldn't be possible without a dependable core group of maintainers.

Next, we thank the Nerves community. Thanks for being a welcoming and fun place to hang out and experiment with hardware using Elixir.

Finally, we thank the Elixir community and our readers. Authors write to share. Without someone to read what we have to say, the words are empty.

#### **Frank Hunleth**

Writing takes time and focus, especially in this time of pandemic and shortage. I would like to personally thank my wife and two daughters for their love and support. All of you bring so much joy to my life, and I can't imagine how I would have gotten through the stress of finding ways to work around hardware shortages that affected this book without you. Thanks also to Jonatan Kłosko for writing LiveBook and your remarkable customer service as I worked on Nerves LiveBook. The process was way smoother than it had a right to be.

Bruce, thanks for initiating this amazing journey. I can't wait to see where it takes us.

#### **Bruce Tate**

Writing is one of my great joys, but it sometimes takes away from family time. I would like to thank my wife and daughters for their support and understanding. Maggie, thanks for all of your love and support through fifteen books and counting. I love you. Julia and Kayla, I am amazed at what you are becoming. I love you both.

Frank, thanks for your extra measure of support as I took on this project while traveling the Great Loop. Alexa and Frank, your visit on our loop with a wonderful gift inspired and energized me.

### Introduction

This book is one of a series of books about Elixir and Nerves. Each book in this series will teach one fundamental software concept and build one complete project using the Elixir language on Nerves. Elixir<sup>1</sup> is a highly concurrent and reliable functional programming language, and Nerves<sup>2</sup> is a tool for embedding programs on it to build the internet of things, IoT. These devices are small special-purpose computers used to control hardware. They show up in cars, appliances, and more. You might see these nifty devices called different names. In this book, we'll use the terms target, embedded computer, embedded device, controller, and more depending on the context. Regardless of the name, the concepts are the same. We embed a sophisticated program into a tiny computer.

In this book, you'll build such an IoT device—a *binary clock* that cryptically tells time by lighting a series of LEDs and gets the current time from the network. Pure Elixir code will control the clock's display. While a clock is a relatively simple machine, it has many of the same parts as real-life hardware projects. Throughout this book, you'll use the very same principles to organize the software in your own clock as you'd use in any other program.

#### How to Read This Book

This book takes you step by step through the process of building an end-toend binary clock, from the layers of software to the LEDs. If you choose to omit steps, you could wind up with a nonfunctional end product.

#### Who This Book Is For

This book is for any Elixir programmer who is comfortable with the basics of the programming language and is interested in dabbling in the world of

<sup>1.</sup> https://elixir-lang.org

http://nerves-project.org/

embedded systems. No soldering or deep hardware experience is necessary, given that you will be working with off-the-shelf plugin-and-play hardware.

#### Who This Book Isn't For

If you have just a little experience with Elixir, don't worry. We'll help you with some of the more advanced concepts. If you are just getting started, you might want to put this book aside for a bit and pick up *Programming Elixir 1.6 [Tho18].* 

While Elixir 1.6 came out a few years ago now, the core language has not changed much in that time and as such the book will help you develop a solid Elixir foundation. After you read that book, feel free to pick this one up again and get your hands dirty with an IoT-based project.

#### **Building the Project**

Being able to build and run your application code will be key to understanding the concepts outlined in this book. As such it is important that you have the items outlined in the next couple sections so that you have everything you need to complete the binary clock.

#### Software Requirements

Embedded hardware aside, you'll need the following things:

- Elixir version 1.12 or greater
- A Linux, MacOS, or Windows machine to do your development on
- A wireless access point for your local area network

If you have all of those items, then you're good to go from a development machine perspective, and all that is needed is the Nerves related hardware.

#### **Hardware Requirements**

While there is some flexibility with what hardware (like what version Raspberry Pi) you can buy and from where, the following items were used by the authors:

- Raspberry Pi Zero W with headers
- Micro-USB connection data cables
- 4GB+ microSD card
- MicroSD card reader
- 20 LEDs of various colors
- Some resistors
- TLC5947 constant current driver with a SPI interface
- Jumper wires, breadboard, headers, and ribbon cables

If you don't know what these things are or where to buy them, fear not, as we explain all of this in the first few chapters. You can drift away from these parts, but you might need to change the instructions in the book slightly to get things to run.

#### **Online Resources**

All of the code for this project can be found online in the GitHub repository.<sup>3</sup> If you need any assistance for all things Elixir and Nerves, be sure to check out the Elixir Forums<sup>4</sup> where you'll find a vibrant community ready to help. Make sure you mark your post with the Nerves category so the Nerves team will see your post.

If instead you would rather use a more interactive feedback system, the #nerves channel on the Elixir Slack may be your best bet. Since this forum maintains history, the Nerves team prefers this resource so their advice can help many users with the same concerns. If you choose to use Slack, consider adding a post to Elixir Forum to document your problem resolution.

With those bits of housekeeping aside, we can make a plan.

<sup>3.</sup> https://github.com/groxio-learning/thnerves

<sup>4.</sup> https://elixirforum.com