Ten Years of RIOT
The Past, the Presence, the Future

Peter Schmerzl

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Alternative Facts

What could have been?

“We have to rethink the real in order to advance into the possible. “1

1Friedrich Dürrenmatt, Justiz
Collaborating with a Big Player
RIOT on Sale

- arm MBED OS
- Intel
- Zephyr™
- Amazon FreeRTOS
Specialization
The Niche Product

Photo by Kate on Unsplash
Academic Context
The Fate of Research Projects
Agenda

1. What has been
   - Lighthouse Projects
   - RIOT by the Numbers
   - Milestones
   - The Community

2. How it all started
   - RIOT's Roots
   - Anecdotes

3. Pivotal Decisions
   - The Good
   - The Bad
   - The Ugly

4. Where are we going?
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Academia, Industry, Makers

Catering for many Needs

RIOT’s vision from the start was to provide an OS that meets the needs of industrial, academic and private users alike.
Lighthouse Projects
Home Automation with KNX

IoT is not always wireless

Author: Bas Stottelaar, @BasilFX
Vehicle access & telematic unit for car sharing

RIOT can open Doors for you

Author: Continental/OTAkeys

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Ten Years of RIOT
CubeSATS

We are going to outer space ...

Author: ThingsSat, Grenoble university space centre, Didier Donsez
Many amazing Projects

- Torque Wind Turbines
- Energy-Aware Urban Sensing
- A Decentralized Mesh Network as Fallback
- Leak Water Detection
- Dropwatcher: Measuring drip irrigation rate in heap leach for Mining
- Many more...: Check and share at https://www.hackster.io/riot-os
RIOT by the Numbers
Git Statistics

- > 450 Contributors
- ≈ 30,000 Commits
- ≈ 16,500 merged Pull Requests
- ≈ 1,900 Forks on GitHub
Code Statistics

- **C Code:** ≈ 2,100,000 Lines of Code
  - Kernel: ≈ 3,800
  - Network Stack: ≈ 47,000
  - Shell: ≈ 9,500
  - Drivers: ≈ 95,000
  - CPU: ≈ 1,600,000
- **Assembly:** 332 Lines of Code
- **Makefiles:** ≈ 13,000 Lines of Code
Release Statistics

- 36 Releases
- 685 Commits per Release (Median)
- 46 Contributors per Release (Median)
- 1,800,000 Lines of Code per Release (Average)
Feature Statistics

- 264 Supported **Boards**
- 8 **CPU Families**
- 11 **Network Device Drivers**
- 75 **Sensor & Actuator Drivers**
- 101 **Packages**
- 6 **Network Stacks**
Milestones
Core Features

- Lightweight and efficient **Kernel**
- Generic **IP Network Stack**: GNRC
- **Package System** for easy integration of Third Party Code
- **Unified APIs** for Hardware and User Applications
- Fully Integrated **Build System**
IPv6 Networking

- From "Let's implement 6LoWPAN..." (2011)...
- ...to "The border router should be ready soon"...
- ...to "I can ping my Desktop PC" (2015).

Today

Connecting to the Internet is a matter of seconds
Fairs, Exhibitions, and Demos

- Linux Tag
- CEBIT
- IETF Bit'n'Bytes
- Embedded World
- Lange Nacht der Wissenschaften
- ETSI Plugtests (6LoWPAN, CoAP, 6TiSCH)
- Scientific Conferences: Infocom, ICN, EWSN
- And more ...
Industry Collaboration

- Phytec
- Cisco
- Loci Controls
- Eistec
- Continental (OTAKeys)
- Locha Mesh
- Zühlke
- SSV
- WolfSSL
- Mesotics SAS
- TriAgnoSys GmbH
- SODAQ
- ML!PA
- And more...
The Community
Interaction

- Chats (IRC, Matrix ...)
- Mailing Lists and Forum
- Regular Events (Hack’n’Ack, Sprint Day ...)
- GitHub

**devel** Mailing List Traffic

**Forum Traffic**
The Summits

- First Summit in 2016
- Berlin, Amsterdam, Helsinki, Hamburg, Frankfurt, and online

![Graph showing the number of registrations at the Summits from 2016 to 2022. The number of registrations at each Summit varies over the years, with peaks in 2020 and 2018, and a decline in 2022.]
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RIOT's Roots
The Limitations of WSN OS (TinyOS and Contiki)

2009: FeuerWare and Firekernel at FU Berlin

2012: Reboot as µkleos

2013: First Release on GitHub

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The Limitations of WSN OS *(TinyOS and Contiki)*

- **2009**: FeuerWare and Firekernel at FU Berlin
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**Lessons Learned from a Decade of TinyOS**

- Keep it simple
- Stick to the Standards
- Build a Community
- Bundle your Code

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Anecdotes
# Finding a Name

- Fringe OS
- SchmerzlOS
- FOSSIT
- TicklOS
- FreeBearOS
- Wunix
- zeitlOS
- purpOS
- curiOS
- kronOS
- TeepitOS/TepitOS
- TOS/TTOS
- OSOT/OST/OS-T
- SOOS/SmOOS
- OSSO
- FU-BROS
- MyBROS
- FireKernel
- emix
- embrios
How it all started

...and a Logo

First Proposals

RIOT
...and a Logo

First Proposals
...and a Logo

The Counter Proposal
...and a Logo

New Directions

RIOT
...and a Logo

New Directions
...and a Logo

The Idea
...and a Logo

The Idea

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Ten Years of RIOT
...and a Logo

Finally
When we almost sold RIOT

Photo by Jean-Luc Benazet Unsplash
The Good
Open Source and Open Standards

- Be Open
- Stick to the Standards
- Stand on the Shoulders of Giants
Developing Software for Embedded Systems can be painful

Having access to the right Hardware with you is challenging

Debugging and Testing is limited

⇒ Virtualization to the rescue
The Shell

- **Runtime Configuration** instead of Reflashing
- **Interactive Data Retrieval**
- **Easy Access for *NIX Users**

```bash
> ifconfig
Interface 7   HWaddr: 1d:12  Channel: 26  Page: 0  NID: 0x23
   TX Power: 0dBm  State: IDLE  max. Retrans.: 3  CSMA Retries: 4
   ACK_REQ  CSMA  MTU:1280  HL:64  6L0  RTR  IPHC
   Source address length: 8
   Link type: wireless
   inet6 addr: fe80::3432:4833:46:d5:9d12  scope: local VAL
   inet6 group: ff02::1
   inet6 group: ff02::1:ffd5:9d12
   inet6 group: ff02::1 a

> ping6 fe80::3432:4833:46:d8:7 c2a
12 bytes from fe80::3432:4833:46:d8:7 c2a: id=83 seq=1 hop limit=64 time = 6.554 ms
12 bytes from fe80::3432:4833:46:d8:7 c2a: id=83 seq=2 hop limit=64 time = 8.473 ms
12 bytes from fe80::3432:4833:46:d8:7 c2a: id=83 seq=3 hop limit=64 time = 7.193 ms
fe80::3432:4833:46:d8:7 c2a ping statistics
3 packets transmitted, 3 received, 0% packet loss, time 2.0628106 s
rtt min/avg/max = 6.554/7.406/8.473 ms
```
The Bad
Threatful Networking

- GNRC is super powerful and flexible — and super complex
- Threads introduce Runtime and Memory Overhead
- Difficult to trace a Packet through the Stack

Photo by Stephane Gagnon Unsplash
The Build System

- Abusing Make
- Complexity became out of control
- The Transition to KConfig is a neverending Story
- What's next?
The Ugly
Licenses

- The Linux Way
- The Longest Discussion in RIOT's History
- Protection or Handicap?
API Design

- General Purpose
- Heterogeneous Hardware
- Hard to get it right
  - Timers
  - Periph
  - Sockets
  - ...
The Weird
Twisted not available, please install it if you want to use pyterm's JSON capabilities
Twisted not available, please install it if you want to use pyterm's JSON capabilities

- "Nothing lasts longer than a provisional"
- Besides `make` probably the one most frequently called tool
- Yet, noone knows about all its features
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The Roadmap
The Roadmap

Emmanuel Baccelli edited this page May 29, 2020
Where are we going?

The Roadmap

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Evergreen Topics:

- Security
- Power Management
- Build and Configuration Management
- Testing
- Documentation

Even more important:

Do we have a clear vision?

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The Roadmap

Emmanuel Baccelli edited this page May 29, 2020

Evergreen Topics:
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Even more important:
Do we have a clear vision?
Where are we going?

Hostile Environments

In terms of Money and Person Power RIOT cannot compete with ARM, AWS, or Intel

The License and the Community makes RIOT distinctive, but what else?

- Memory Footprint?
- Rust Support?
- Focus on Networking?

Imagine an Internet without Linux - Do we want an IoT without FLOSS?
Credits
RIOT's League of Legends

RIOT has a hero
RIOT's League of Legends

RIOT has a hero

Its Community
Unsung Heroes

- The Forefather: Kaspar Schleiser (@kaspar030)
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Unsung Heroes

- The Forefather: Kaspar Schleiser (@kaspar030)
- Number One: Alexandre Abadie (@aabadie)
- The Shepherd: Peter Kietzmann (@PeterKietzmann)
- Mr. Native: Ludwig Knuepfer (@LudwigKnuepfer)
- Executives: Emmanuel Baccelli, Thomas Schmidt, Matthias Wählish
Steady Contribution

Some Contributors' Commit Statistics look like"
Steady Contribution

Some Contributors' Commit Statistics look like

[Graph]

Other's look like

[Graph]
Steady Contribution

Some Contributors' Commit Statistics look like

Other's look like

But whose look like this?
RIOT's Unsung Heroine is actually a singing Heroine:

Martine Lenders aka @miri64
www.riot-os.org