

# XOUS

## EMBEDDED MULTIPROCESS MICROKERNEL

17 APRIL 2024, SEAN CROSS

# OUTLINE

1. About Me
2. Project history
3. Why a new OS?
4. What can it do?
5. How do I use it?

# ABOUT ME

- Live in Singapore
- Enjoy understanding systems
- Low-level is best

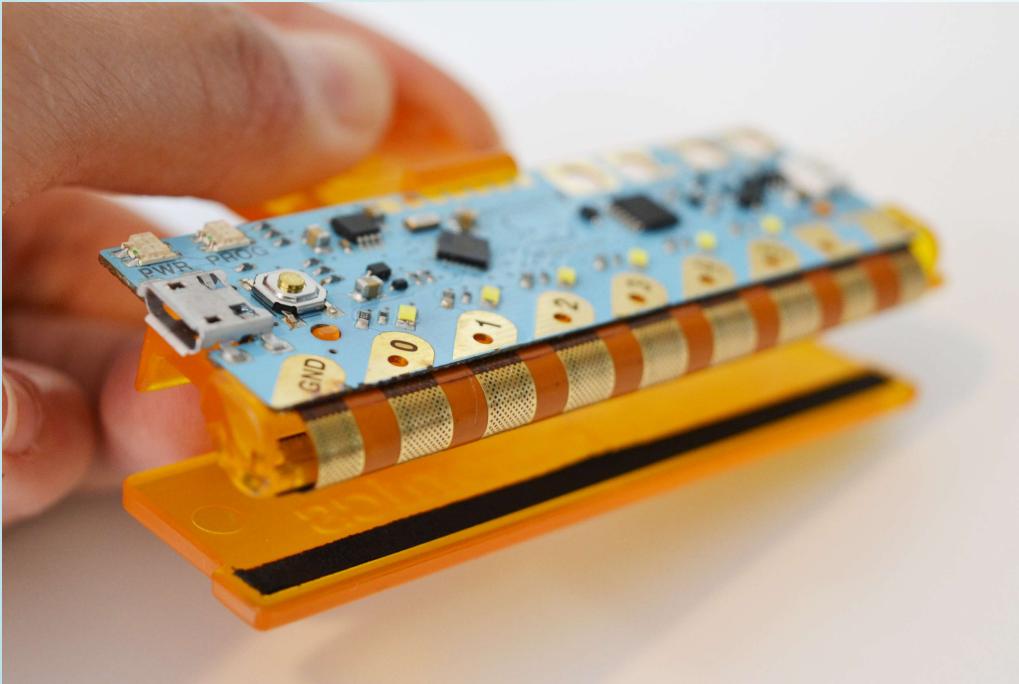
# NOVENA: OPEN LAPTOP



- Always wanted custom laptop
- "Large" Cortex A9
- 32 GB disk, 4 GB RAM
- Linux

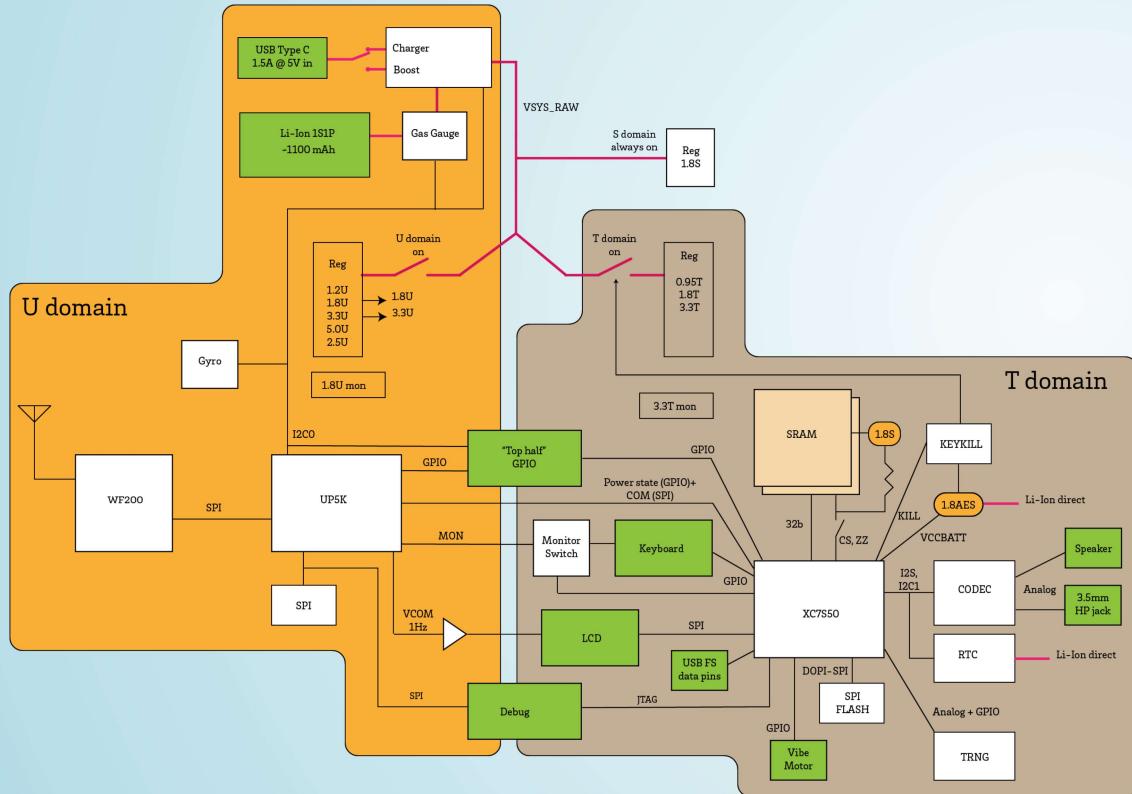


# CHIBITRONICS: PROGRAMMING FOR 8-YEAR-OLDS



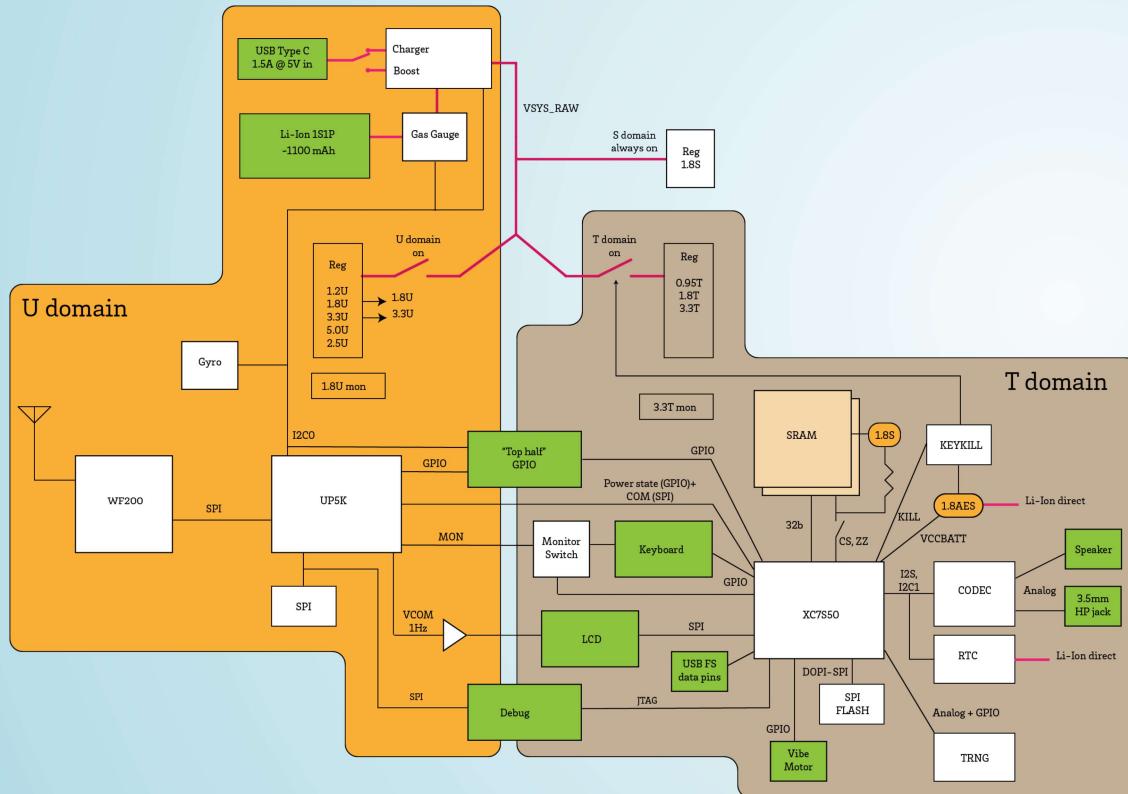
- Paper circuit design
- "Small" Cortex M0+
- 32 kB flash, 4 kB RAM
- ChibiOS

# PRECURSOR DESIGN



- Two FPGA-based CPUs
- RV32IMAC based on VexRiscv
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- Operating System?

# ARM Architecture: For Diverse Embedded Processing Needs

## Cortex - A

Highest performance

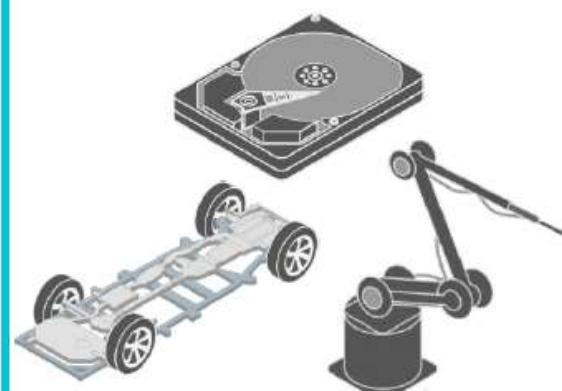
Optimised for  
rich operating systems



## Cortex - R

Fast response

Optimised for  
high performance,  
hard real-time applications



## Cortex - M

Smallest/lowest power

Optimised for  
discrete processing and  
microcontrollers



# MMUS ARE AMAZING

- XIP flash for free!
- Swap space
- Encrypted swap? No problem!
- Realtime patching broken hardware

# OPERATING SYSTEM SELECTION

- MMU Required
- RISC-V
- Not Linux

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- MMU Required
- RISC-V
- Not Linux
- Rust is a new thing?

XOUS DESIGN

# BRIEF SPECS

- Kernel is 17k sloc
- Threads
- Processes
- Tier 2 Rust support

# OTHER FEATURES

- Microkernel
- Interrupts in userspace
- All drivers provided in user space
- Each page of memory is mapped once
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- Services use well-defined API calls
- Only **stable** Rust
- No C compiler required

# MESSAGES ARE EVERYTHING

- Messages form IPC
- Scalars or Pages
- Blocking or Nonblocking

# EXAMPLE: SLEEPING

`sleep(msc: usize)`

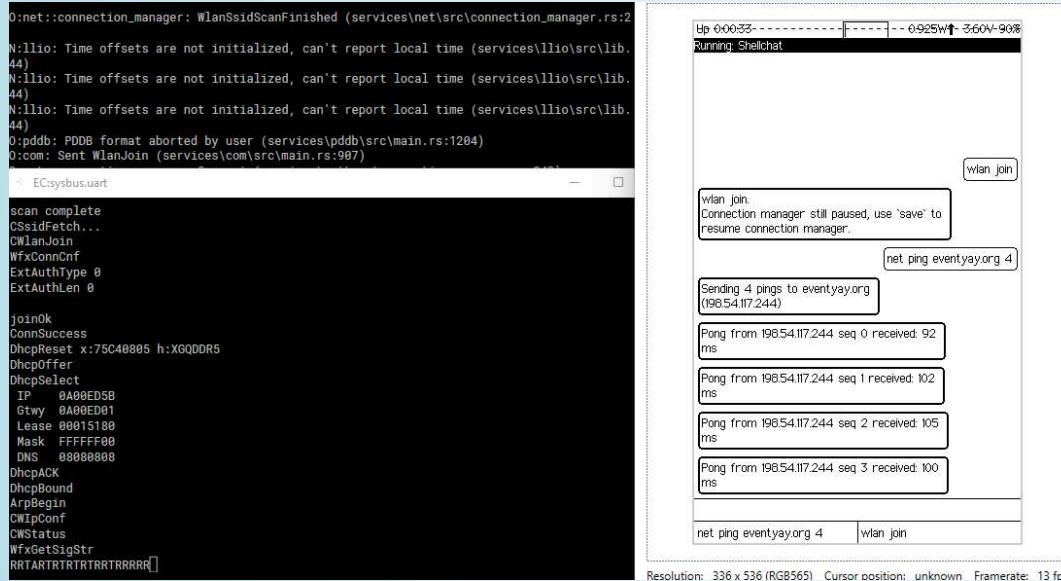
1. Connect to "ticktimer" server
2. Send a `BlockingScalar` with desired duration
3. Client will block until server replies
4. Server calls `ReturnScalar()` after expiration

# EXAMPLE: MUTEX

`mutex.lock().unwrap()`

1. Fast path with `AtomicIsize`
2. Slow path by sending `LockMutex`
3. On unlock, contending thread will see poison and send `UnlockMutex`
4. Server will reply to `LockMutex` message to unblock the thread

# HOW CAN I USE IT?



The image shows a debugger interface with two panes. The left pane displays a log of system events:

```
0:net::connection_manager: WlanSsidScanFinished (services\net\src\connection_manager.rs:2
N:llio: Time offsets are not initialized, can't report local time (services\llio\src\lib.
44)
N:llio: Time offsets are not initialized, can't report local time (services\llio\src\lib.
44)
N:llio: Time offsets are not initialized, can't report local time (services\llio\src\lib.
44)
0:ppdb: PDB format aborted by user (services\ppdb\src\main.rs:1204)
0:com: Sent WlanJoin (services\com\src\main.rs:907)
< E:\sysbusuart
scan complete
C:\sysbusuart
C:\WlanJoin
WfxConnCnf
ExtAuthType 0
ExtAuthLen 0
joinOk
ConnSuccess
DhcpReset x:75C40805 h:XGQDDR5
DhcpOffer
DhcpSelect
IP 0A80ED5B
Gtwy 0A98FD91
Lease 00015180
Mask FFFFFF00
DNS 08080808
DhcpACK
DhcpBound
ArpBegin
CWIPConf
CWStatus
WfxGetSigStr
RRTRTRTRTRTRTRRRRR]
```

The right pane shows a terminal window titled "Running: Shellchat". It has a message box with the text "wlan join" and a status message: "Connection manager still paused, use 'save' to resume connection manager.". Below this, it shows a ping session:

```
Sending 4 pings to eventyay.org (192.54.117.244)
Pong from 192.54.117.244 seq 0 received: 92 ms
Pong from 192.54.117.244 seq 1 received: 102 ms
Pong from 192.54.117.244 seq 2 received: 105 ms
Pong from 192.54.117.244 seq 3 received: 100 ms
```

At the bottom of the terminal window, there are buttons for "net ping eventyay.org 4" and "wlan join".

Resolution: 336 x 536 (RGB565) Cursor position: unknown Framerate: 13 fms

- Talk to system vendors -- get them to include MMUs!
- Emulation is easiest -- Renode support

# THANK YOU!

GITHUB.COM/BETRUSTED-IO/XOUS-CORE