

**Florian Edelmann**

# Using a Raspberry Pi as a PC-DMX interface

Bachelor's Thesis – final presentation

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Advisors: Dr. Nils gentschen Felde  
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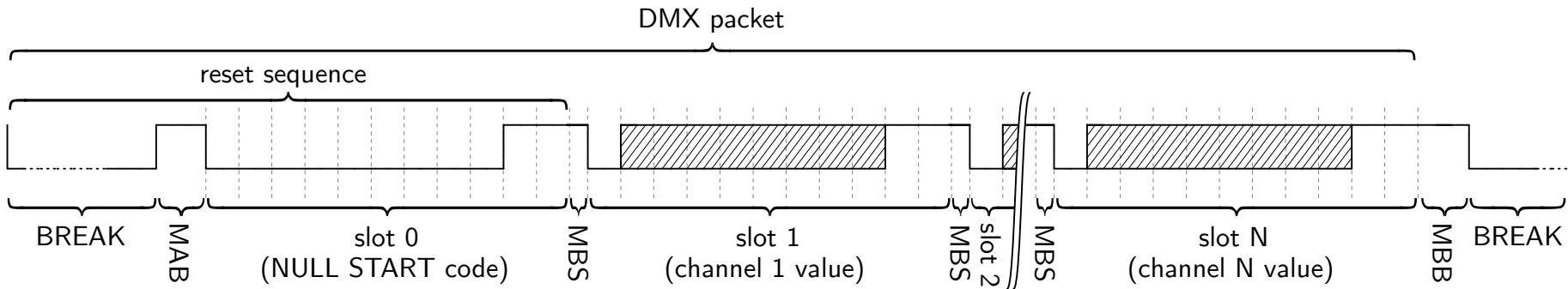


## Technical background (1): What is DMX?

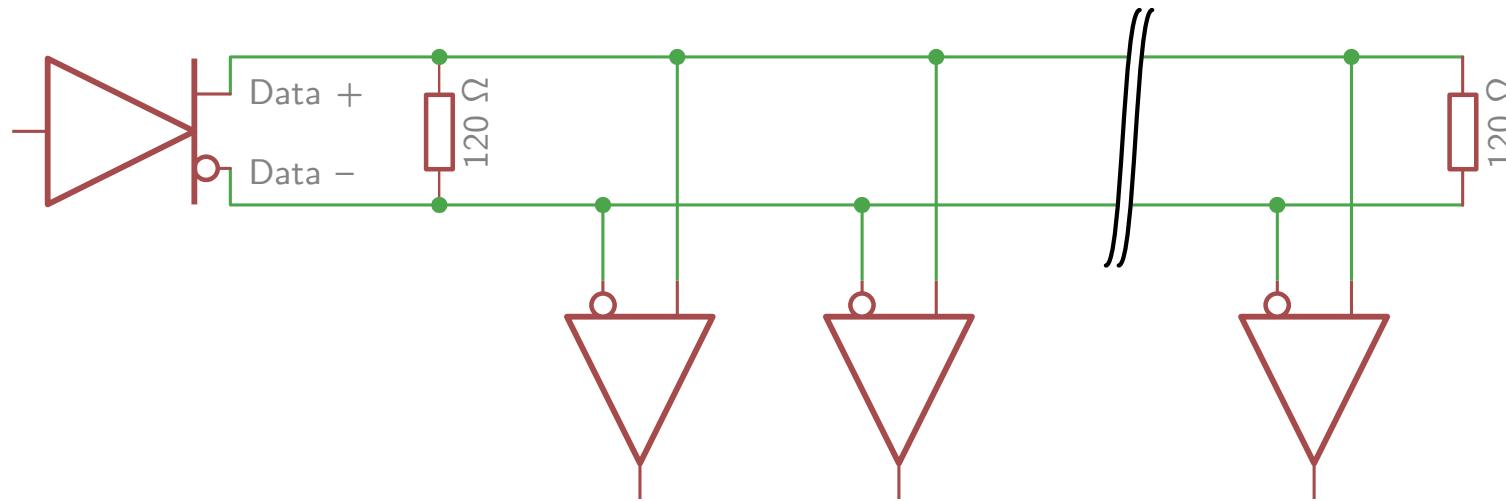


- Entertainment Services and Technology Association standard *DMX512-A* (2013)
- Digital Multiplex with 512 individual pieces of information
- first version: U.S. Institute for Theatre Technology (1986)
- Used to control lighting fixtures
  - Spotlights, Strobe lights, Moving heads, Scanners
- Value for each of 512 channels: integer 0...255
- DMX source: desk consoles / lighting control software

## Technical background (2): DMX protocol

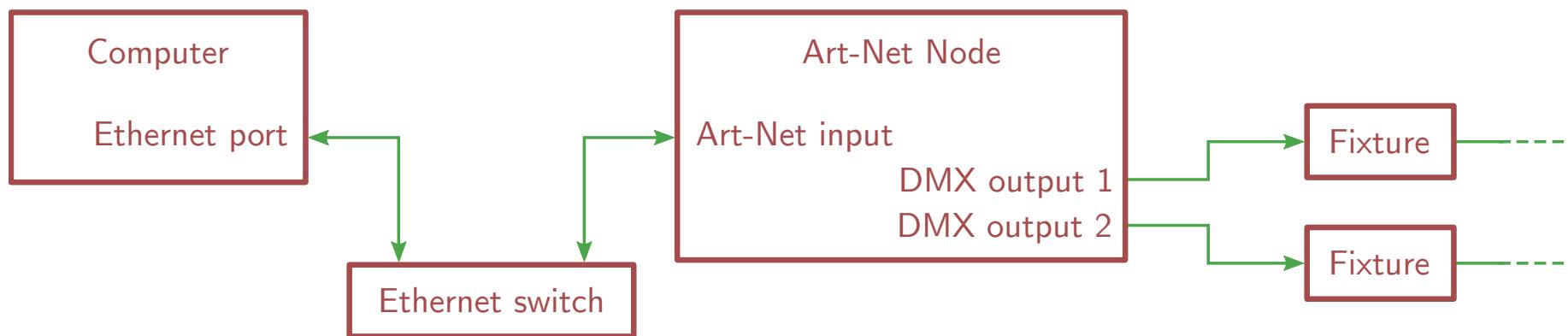


- Recognizing DMX packet start: BREAK
  - low signal longer than one slot time
- Other slots contain channel values
- Not all 512 channels have to be included → faster refresh

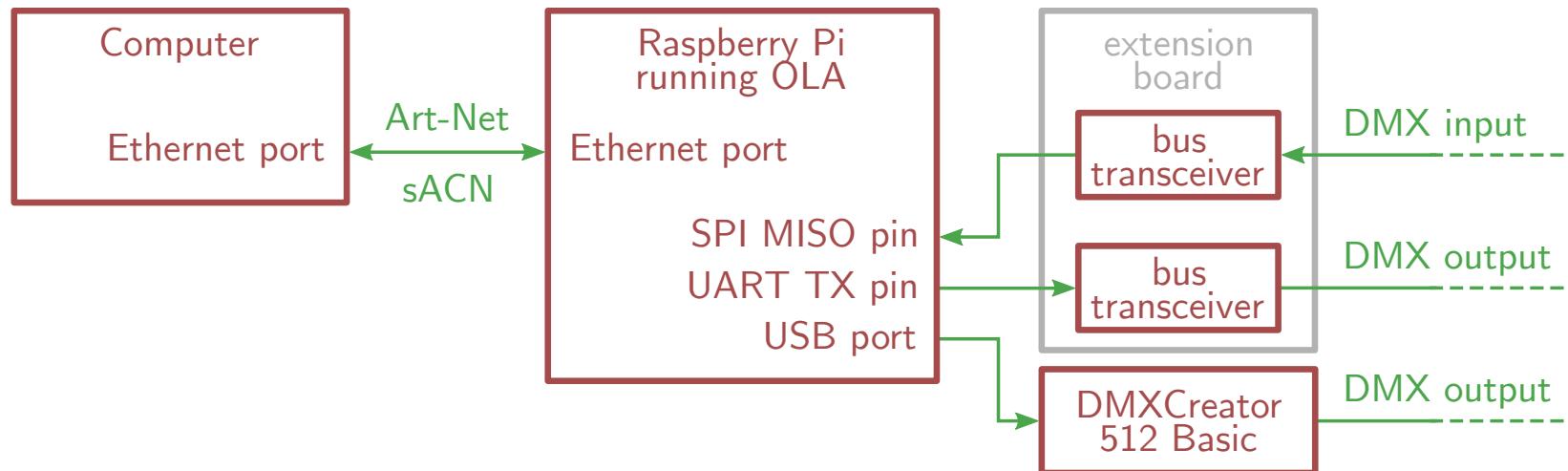


- Based on EIA-485: differential bus
  - Data encoded by potential difference between Data + and Data –
  - Decreases interference liability
  - Noise adds to both data lines equally → cancels itself out
  - Termination resistors (120 ohms) prevent reflections

- Created by Artistic License (1998)
- DMX over UDP (multiple universes per IP address)
  - Allows to use standard network equipment
- Common setup: Art-Net Node



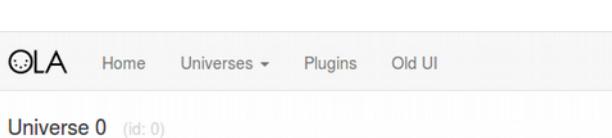
- Easy for end-users
- Less than 100€ in total
- Extensible (e.g. more DMX inputs / outputs)
- Open-source



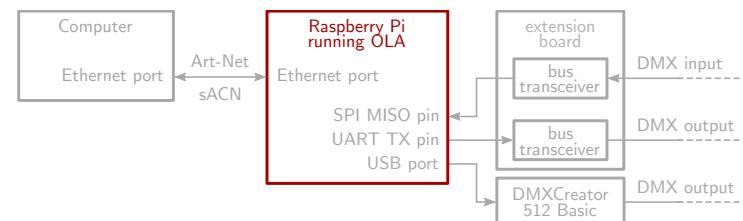
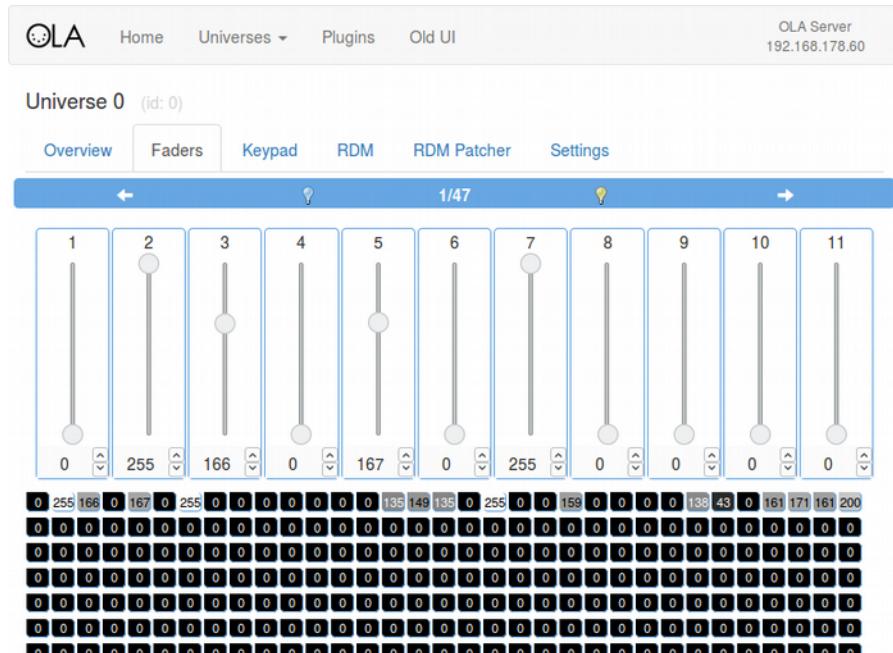
# Market study:

## Available interfaces < 100€

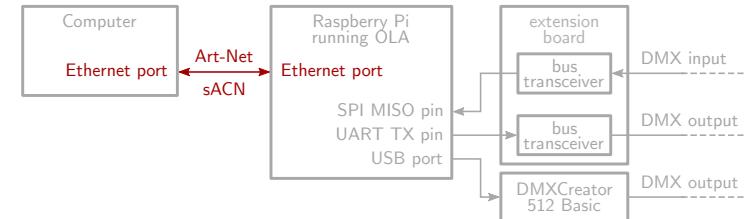
Product	Simultaneous output / input universes	Flexible input mapping	Open / Extensible	Connection to computer
Professional USB-to-DMX adapters	1 ✗ / 0 ✗	N/A ✗	✗ / ✗	USB ✗
Eurolite Art-Net/DMX Node 1	1 ✗ / 0 ✗	N/A ✗	✗ / ✗	Art-Net ✓
DMXControl Projects Nodle U1	1 ✗ / 1 ✓	✗	✓ / ✗	USB ✗
DMXControl Wiki AvrArtNodeV2.0	2 ✓ / 0 ✗ (0 ✗ / 2 ✓)	N/A ✗	✓ / ✗	Art-Net ✓
mtongnz ESP8266_ArtNetNode_v2	2 ✓ / 0 ✗ (1 ✗ / 1 ✓)	✗	✓ / ✗	Art-Net ✓
Ulrich Radig Quad Art Net Box	3 ✓ / 1 ✓ (4 ✓ / 0 ✗)	✗	✓ / ✗	Art-Net ✓
Raspberry Pi Art-Net 3 -> DMX Out	1 ✗ / 1 ✓	✗	✓ / ✓	Art-Net + others ✓

- Open-source software to convert different protocols to / from DMX
  - Raspberry Pi version available
  - Web interface

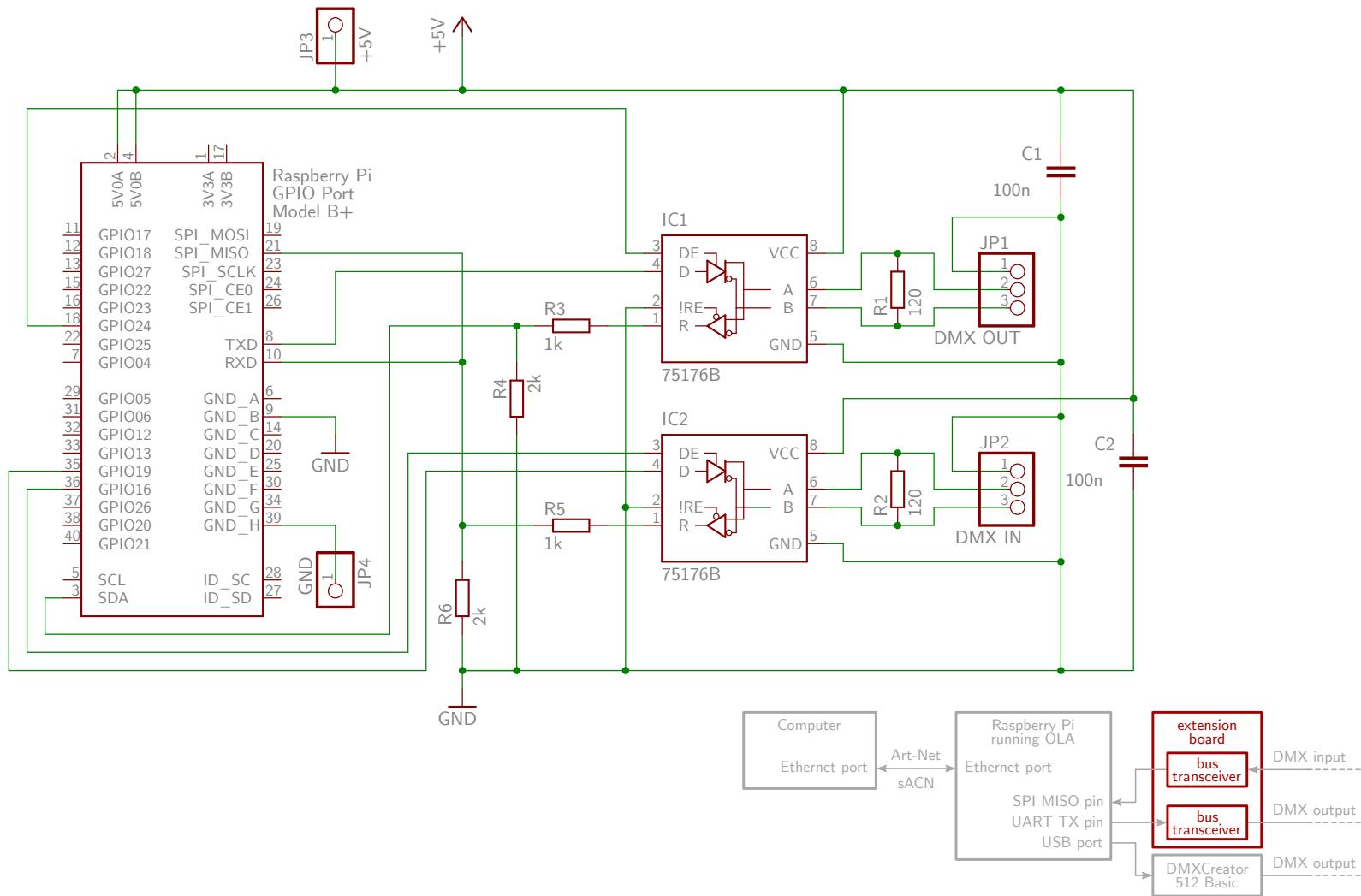
The screenshot shows the OLA web interface for Universe 0. The top navigation bar includes links for Home, Universes (with a dropdown menu), Plugins, and Old UI. On the far right, there's a user icon and the number 192. Below the navigation, a sub-header reads "Universe 0 (id: 0)". A horizontal tab bar below the header includes Overview (which is selected and highlighted in blue), Faders, Keypad, RDM, RDM Patcher, and Settings. The main content area features a row of ten vertical sliders labeled 1 through 10. Sliders 2, 3, and 7 have their circular knobs moved to the right, while the others are at the left end. Above the sliders, a blue header bar displays navigation icons (left arrow, lightbulb, right arrow), the text "1/47", and another lightbulb icon.



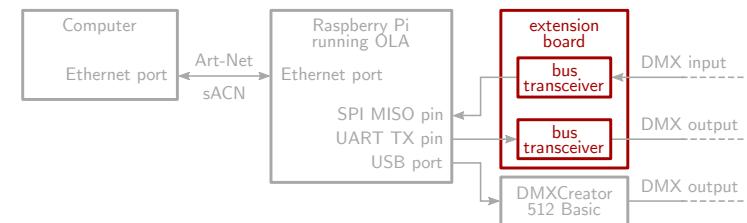
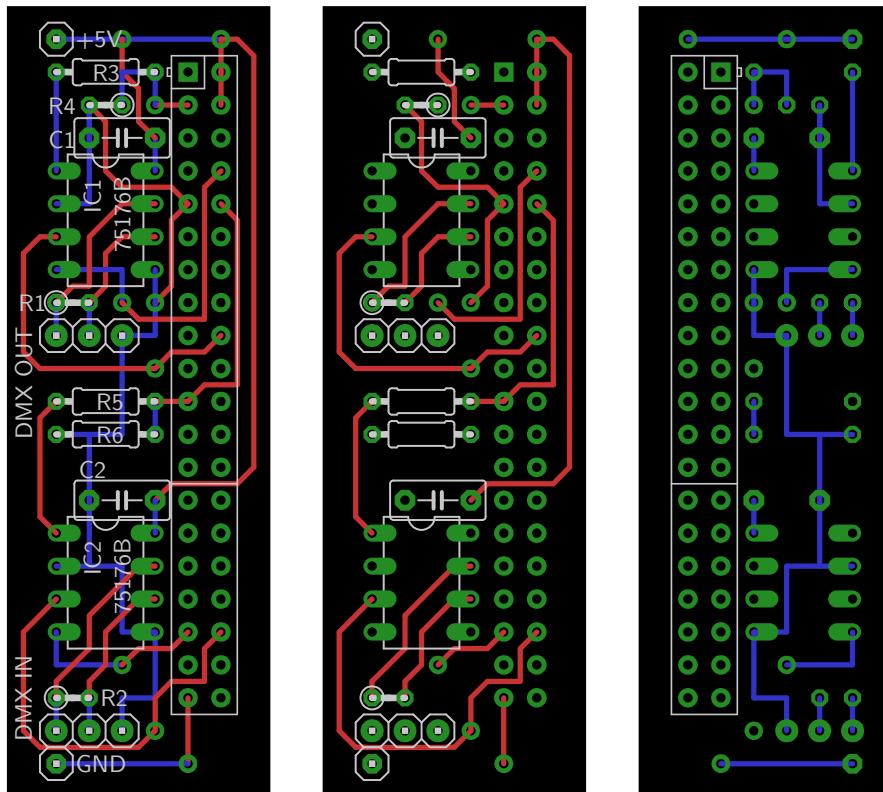
- Does already exist



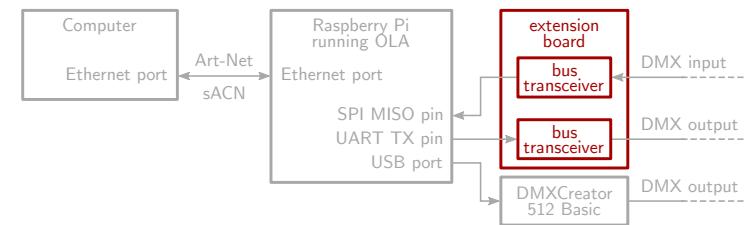
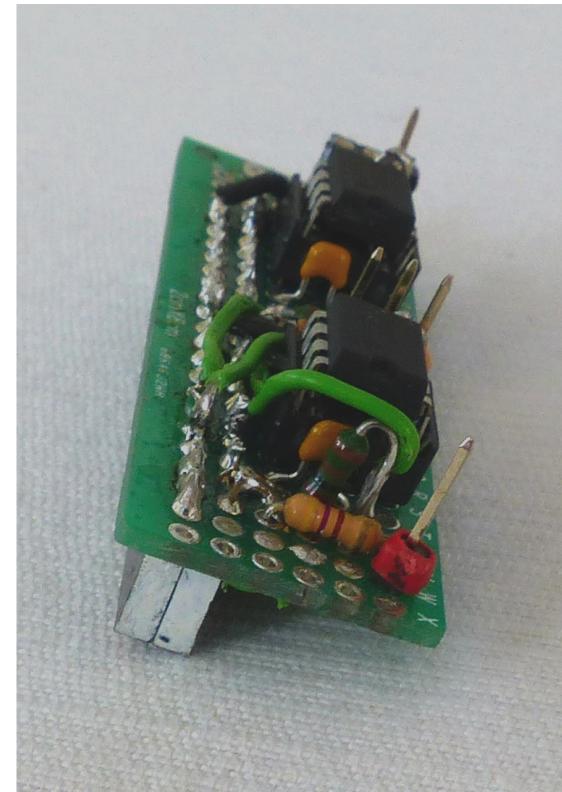
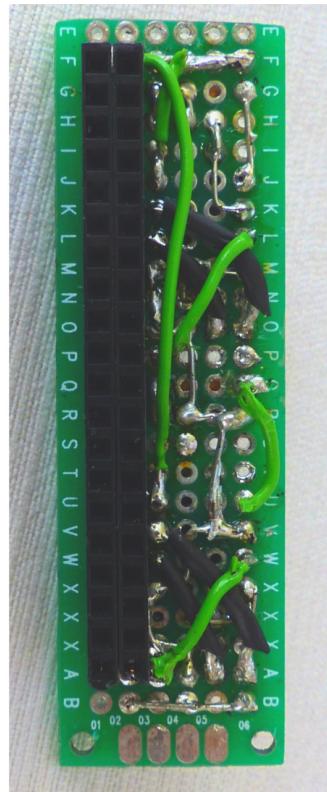
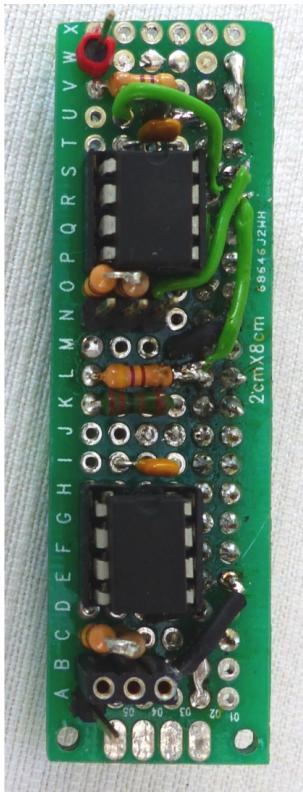
# Electrical engineering (1): Schematic



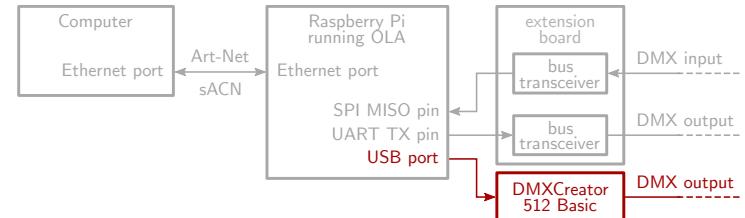
# Electrical engineering (2): Layout



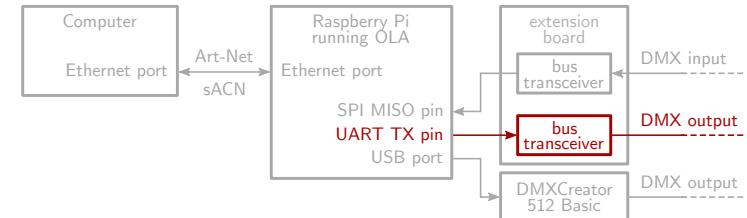
# Electrical engineering (3): Photos



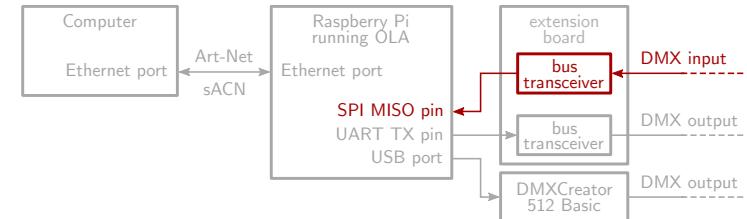
- Reverse engineering USB traffic with Wireshark
- Implementation as USB DMX sub-plugin
- Provides one DMX output port



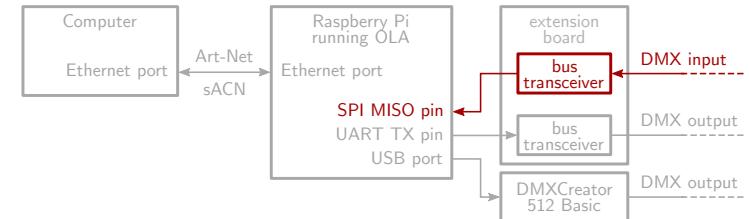
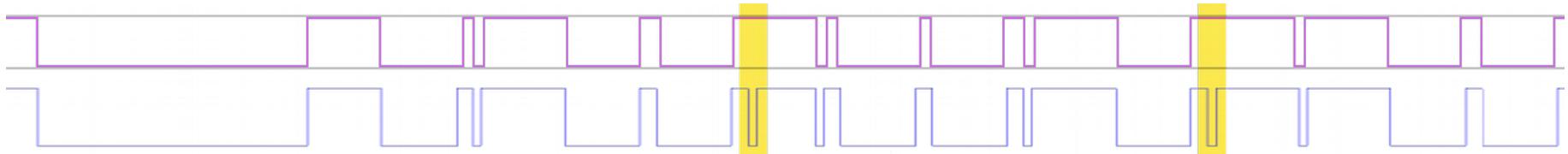
- Universal Asynchronous Receiver Transmitter
  - Serial protocol, often in microcontrollers (EIA-232)
  - Slots, start bits, stop bits, BREAK → similar to DMX
- Existing plugin provides one DMX output port



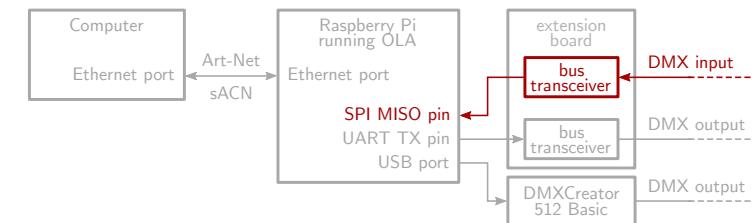
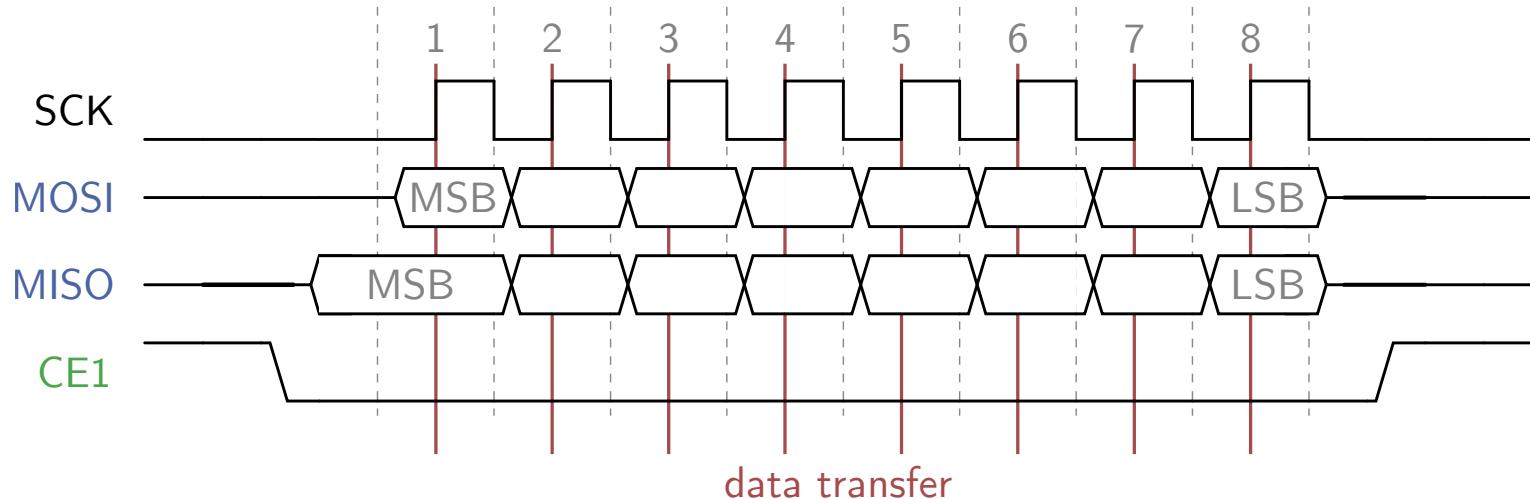
- Extension of Native UART DMX Plugin
  - High-level interface
  - BREAK detection difficult: How to distinguish 0 value from BREAK?
  - Only random data after a while → UART possibly confused by BREAKs



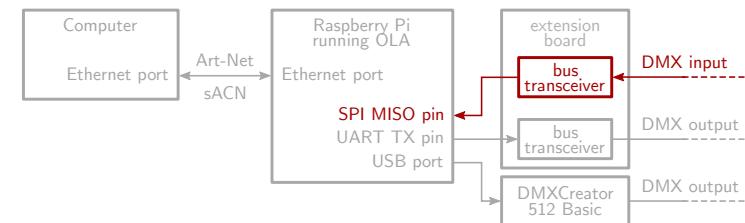
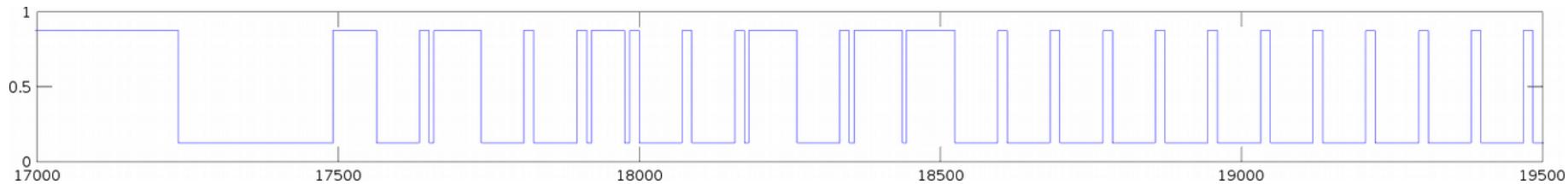
- Bit bang reading GPIO pins
  - Too inaccurate at 250kbit/s



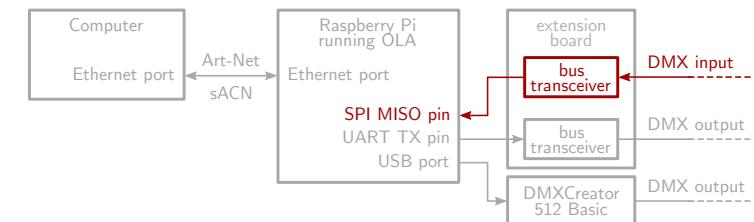
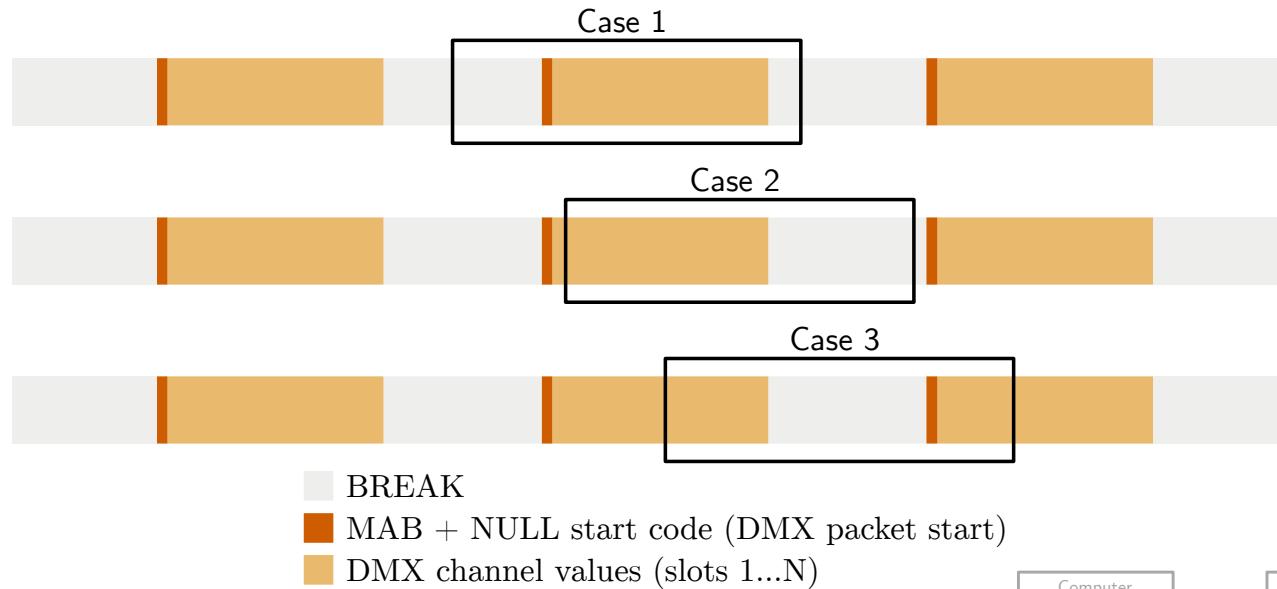
- Serial Peripheral Interface
  - SCK (synchronous), MISO, MOSI, CE lines
  - Master and slave(s) simultaneously read / write



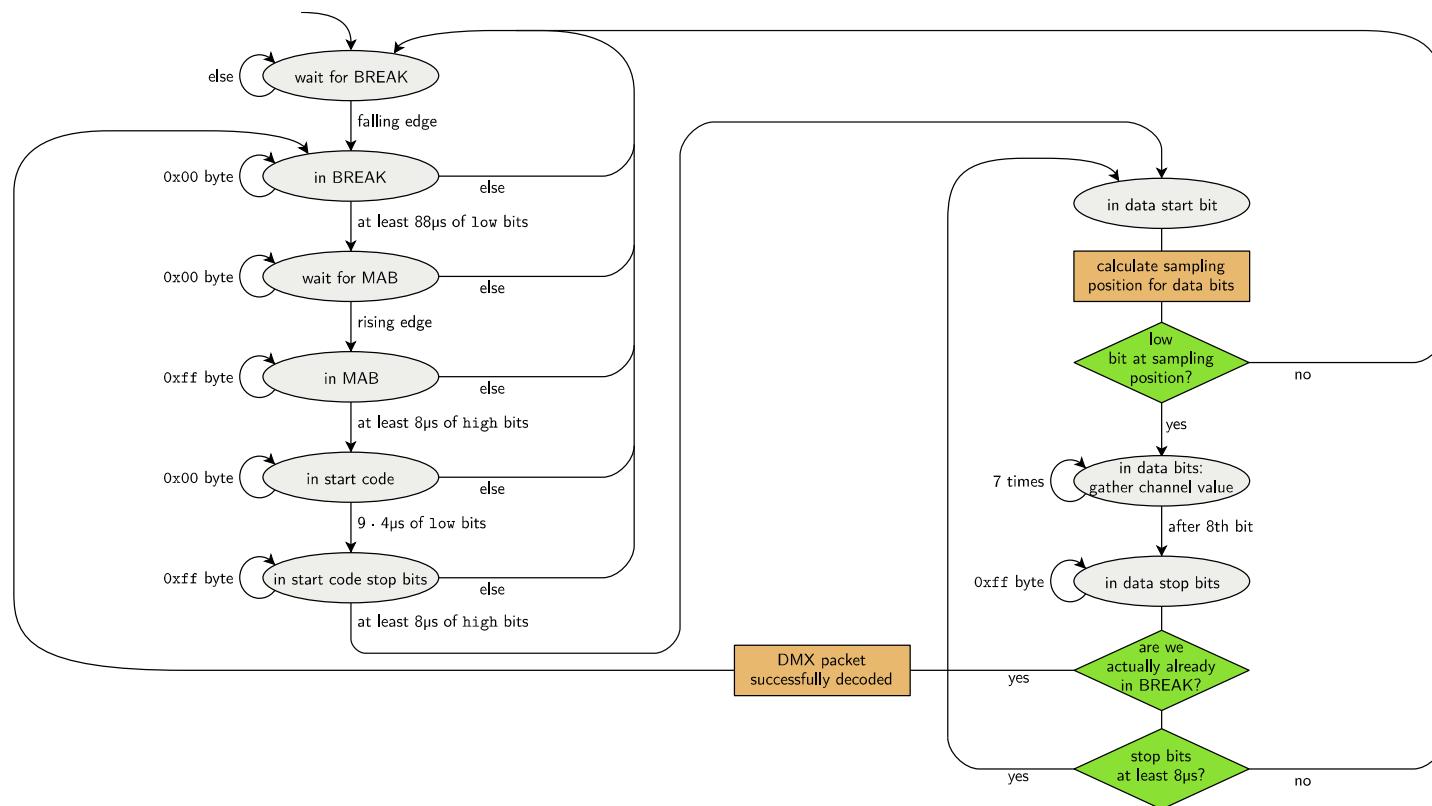
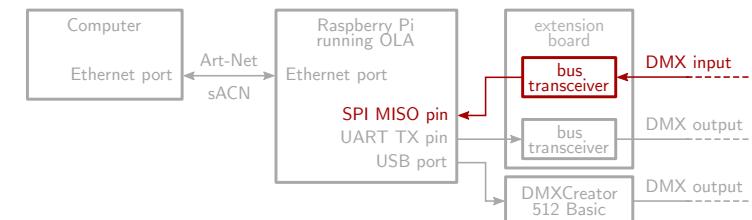
- SPI designed for higher speeds → separate timing
  - 8x oversampling (2MHz)
- DMX signal fed into MISO pin, other pins unconnected
- Proof of concept: Receive and plot in GNU Octave



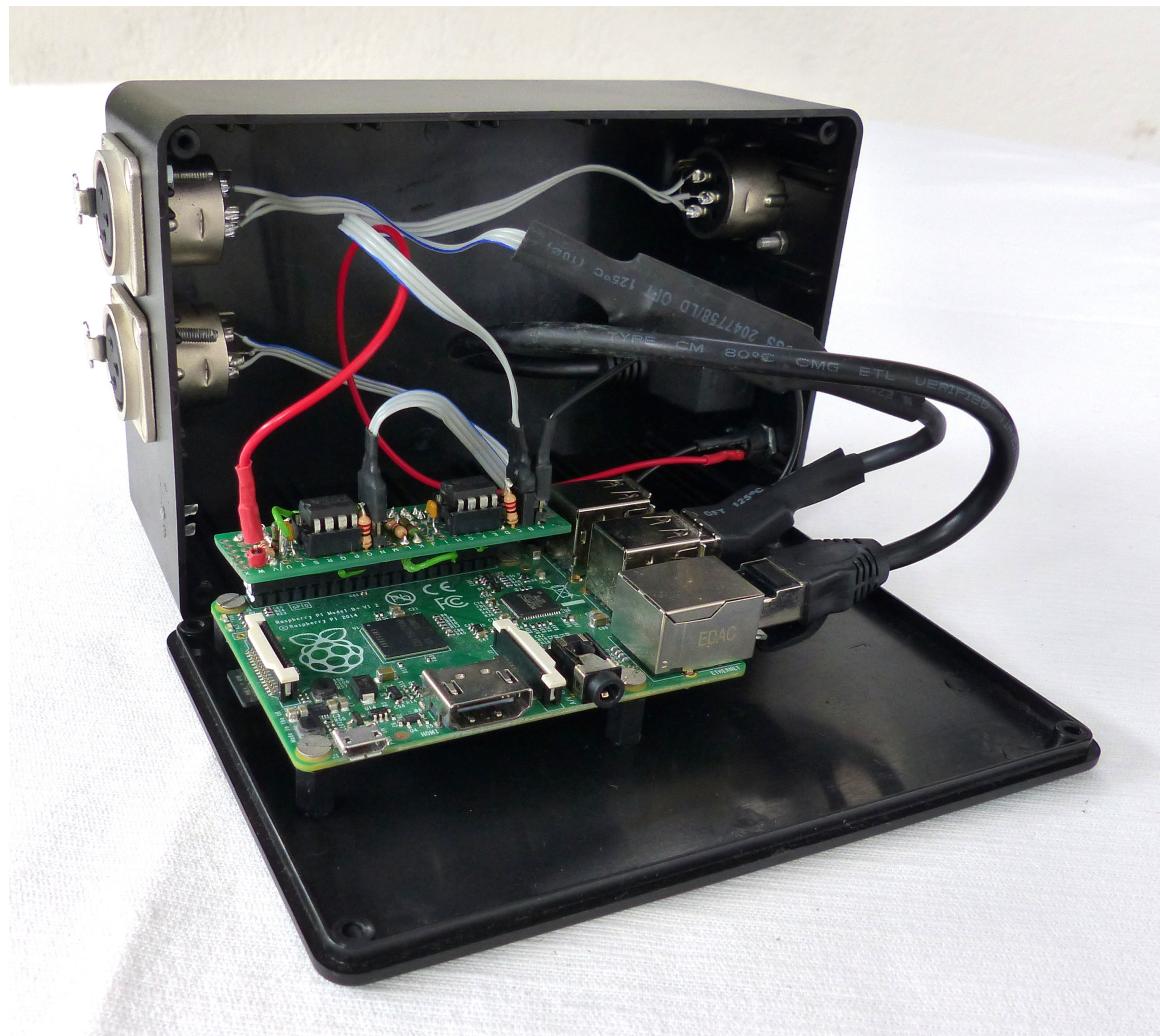
- SPI chunks separated by uncaptured gaps
- No stream parsing possible



# Native SPI DMX Plugin (6): SPI sampling state machine

DMX packet  
successfully decoded

# Finished PC-DMX interface

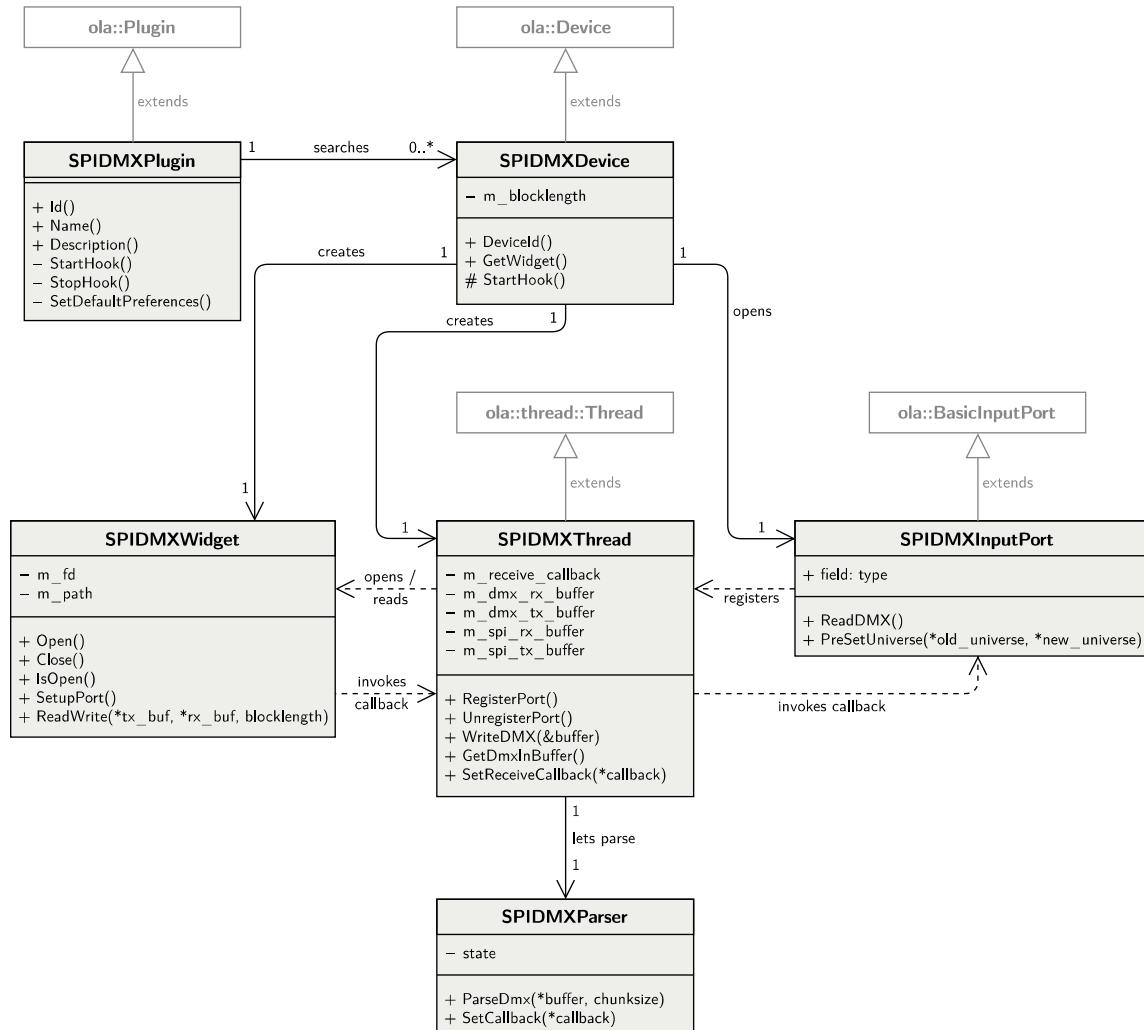


# Manual testing



# Backup slides

# Native SPI DMX Plugin (7): Wrapping into OLA Plugin



- More Raspberry Pi-native output ports
  - SPI MOSI (promising)
  - GPIO bit banging (worth investigating)
- Remote Device Management (RDM)
  - Bidirectional DMX protocol extension
  - Input & output port together needed
- Improve network management
  - Hardware switch for *master* mode
  - Master runs DHCP server and provides Wi-Fi access point