OpenRTX: an open source firmware for ham radio devices

Silvano Seva - IU2KWO

4th February 2024

whoami

- Also known as Redman
- Born and living in Milan, Italy
- Ham radio operator since 2017 as IU2KWO
- Firmware developer by profession (and by passion)
- Co-founder and developer of OpenRTX
- Member of the M17 team since 2021

OpenRTX

OpenRTX

- *An open-source firmware for ham radio devices*

OpenRTX

- An open-source firmware for ham radio devices
- *Designed to be:*

OpenRTX

- An open-source firmware for ham radio devices
- Designed to be:
  - *modular*

OpenRTX

- An open-source firmware for ham radio devices
- Designed to be:
  - modular
  - *easily portable to new devices*

OpenRTX

- An open-source firmware for ham radio devices
- Designed to be:
  - modular
  - easily portable to new devices
  - *easily extendable to new protocols*

OpenRTX

- An open-source firmware for ham radio devices
- Designed to be:
  - modular
  - easily portable to new devices
  - easily extendable to new protocols
- *Currently supporting FM and M17 modes*

Timeline

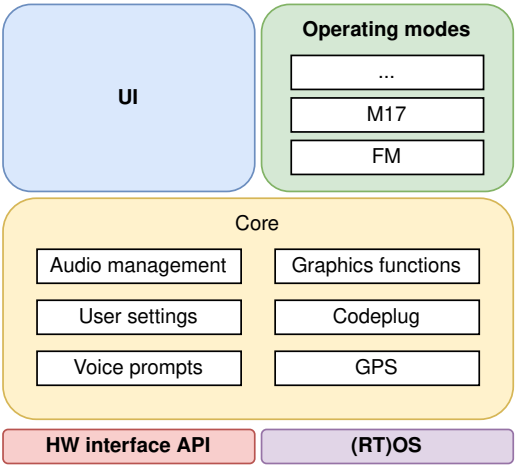
Timeline

- *March 2020*: project starts as a port of OpenGD77 to the TYT MD-380
- *September 2020*: original idea abandoned, "official" beginning of OpenRTX
- *January 2021*: first alpha release with working FM on the TYT MD-380
- *February 2021*: first TX tests of M17 mode on the MD-380
- *April 2021*: support for GD-77, DM-1801 and MD-UV380
- *May 2022*: release v0.3.3 brings full support for M17 voice transmission
- *November 2022*: implemented voice prompts for vision impaired operators
- *October 2023*: support for Lilygo T-TWR Plus (and various technical improvements)
- *More to come ...*

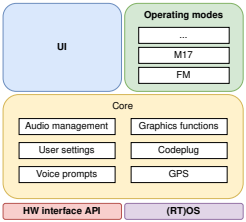
Supported devices

- TYT MD-380/Retevis RT3 (FM, M17)
- TYT MD-UV380/Retevis RT3s (FM, M17)
- Radioditty GD-77 (FM)
- Baofeng DM-1801 (FM)
- Module17 (M17)
- Lilygo T-TWR Plus (FM)

Internals

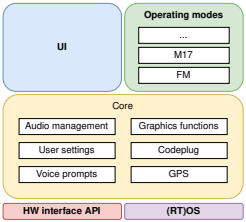

UI
Operating modes
...
M17
FM
Core
Audio management
Graphics functions
User settings
Codeplug
Voice prompts
GPS
HW interface API
(RT)OS

Internals


UI
Operating modes
...
M17
FM
Core
Audio management
Graphics functions
User settings
Codeplug
Voice prompts
GPS
HW interface API
(RT)OS

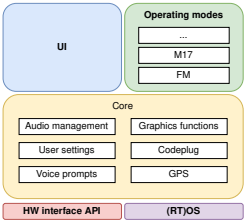
Internals

- *Interface with the operating system:*



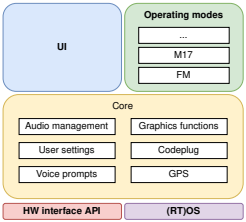
Internals

- Interface with the operating system:
  - *thread management done using the Posix API*



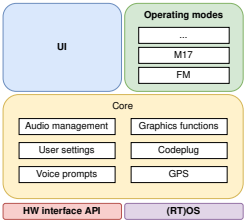
Internals

- Interface with the operating system:
  - thread management done using the Posix API
  - *all the remaining parts use the standard C library*

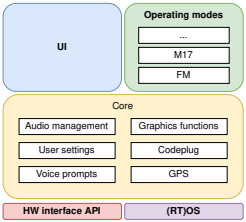


Internals

- Interface with the operating system:
  - thread management done using the Posix API
  - all the remaining parts use the standard C library
  - *an RTOS is preferred on embedded devices*

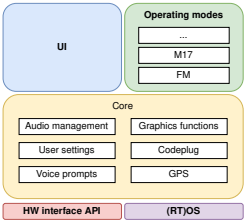


Internals



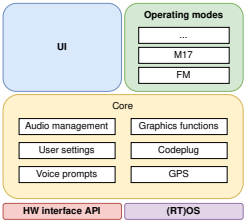
- Interface with the operating system:
  - thread management done using the Posix API
  - all the remaining parts use the standard C library
  - an RTOS is preferred on embedded devices
- *Interface with the hardware:*

Internals



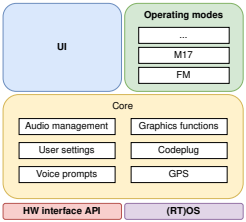
- Interface with the operating system:
  - thread management done using the Posix API
  - all the remaining parts use the standard C library
  - an RTOS is preferred on embedded devices
- Interface with the hardware:
  - *APIs for display, keyboard, audio, radio and nonvolatile memory*

Internals



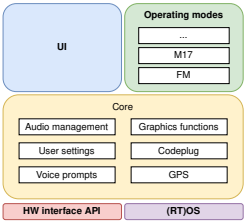
- Interface with the operating system:
  - thread management done using the Posix API
  - all the remaining parts use the standard C library
  - an RTOS is preferred on embedded devices
- Interface with the hardware:
  - APIs for display, keyboard, audio, radio and nonvolatile memory
  - *"platform" API for device initialization and other stuff (LEDs, ...)*

Internals



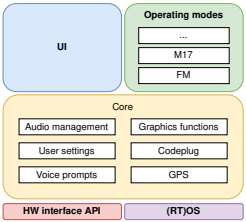
- Interface with the operating system:
  - thread management done using the Posix API
  - all the remaining parts use the standard C library
  - an RTOS is preferred on embedded devices
- Interface with the hardware:
  - APIs for display, keyboard, audio, radio and nonvolatile memory
  - "platform" API for device initialization and other stuff (LEDs, ...)
  - *more devices can share a single API implementation (e.g. the display driver for MDx)*

Internals


UI
Operating modes
...
M17
FM
Core
Audio management
Graphics functions
User settings
Codeplug
Voice prompts
GPS
HW interface API
(RT)OS

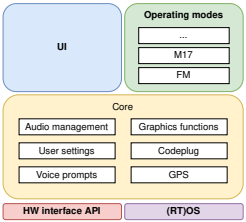
Internals

- *User interface:*



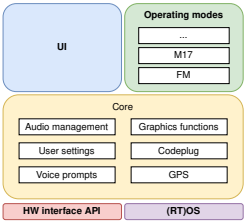
Internals

- User interface:
  - *currently a "standard" GUI + an ad-hoc GUI for Module17*

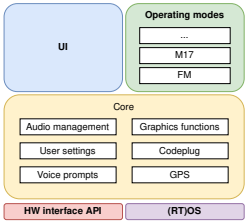


Internals

- User interface:
  - currently a "standard" GUI + an ad-hoc GUI for Module17
  - *you can write your own from scratch, if you want*

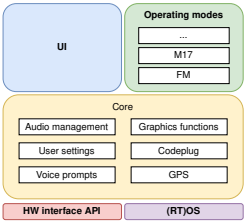


Internals



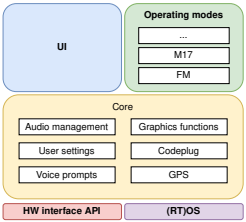
- User interface:
  - currently a "standard" GUI + an ad-hoc GUI for Module17
  - you can write your own from scratch, if you want
  - *future plans to make the standard GUI scriptable/expandable*

Internals



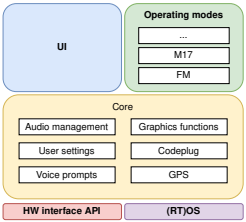
- User interface:
  - currently a "standard" GUI + an ad-hoc GUI for Module17
  - you can write your own from scratch, if you want
  - future plans to make the standard GUI scriptable/expandable
- *Operating modes/protocols:*

Internals



- User interface:
  - currently a "standard" GUI + an ad-hoc GUI for Module17
  - you can write your own from scratch, if you want
  - future plans to make the standard GUI scriptable/expandable
- Operating modes/protocols:
  - *C++ here, but simple*

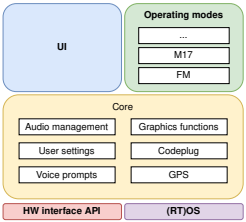
Internals



- User interface:
  - currently a "standard" GUI + an ad-hoc GUI for Module17
  - you can write your own from scratch, if you want
  - future plans to make the standard GUI scriptable/expandable

- Operating modes/protocols:
  - C++ here, but simple
  - *all the operating modes are subclasses of a generic "OpMode" class*

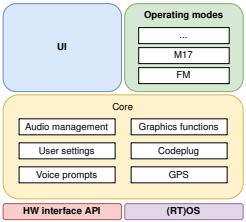
Internals



- User interface:
  - currently a "standard" GUI + an ad-hoc GUI for Module17
  - you can write your own from scratch, if you want
  - future plans to make the standard GUI scriptable/expandable

- Operating modes/protocols:
  - C++ here, but simple
  - all the operating modes are subclasses of a generic "OpMode" class
  - *pre-defined functions: enable, disable, periodic update (33Hz), squelch status*

Internals



- User interface:
  - currently a "standard" GUI + an ad-hoc GUI for Module17
  - you can write your own from scratch, if you want
  - future plans to make the standard GUI scriptable/expandable

- Operating modes/protocols:
  - C++ here, but simple
  - all the operating modes are subclasses of a generic "OpMode" class
  - pre-defined functions: enable, disable, periodic update (33Hz), squelch status
  - *still some work to do: functions to get/set mode-specific data (e.g. configuration)*

M17 support

- *First work done on the TYT MD-380, then extended to the MD-UV380*

M17 support

- First work done on the TYT MD-380, then extended to the MD-UV380
- *Everything is handled in the MCU*

M17 support

- First work done on the TYT MD-380, then extended to the MD-UV380
- Everything is handled in the MCU
- *Hardware must have the following connections:*

M17 support

- First work done on the TYT MD-380, then extended to the MD-UV380
- Everything is handled in the MCU
- Hardware must have the following connections:
  - *mic to MCU*

M17 support

- First work done on the TYT MD-380, then extended to the MD-UV380
- Everything is handled in the MCU
- Hardware must have the following connections:
  - mic to MCU
  - *RF stage to MCU, DC to ∼3kHz*

M17 support

- First work done on the TYT MD-380, then extended to the MD-UV380
- Everything is handled in the MCU
- Hardware must have the following connections:
  - mic to MCU
  - RF stage to MCU, DC to ∼3kHz
  - *MCU to speaker*

M17 support

- First work done on the TYT MD-380, then extended to the MD-UV380
- Everything is handled in the MCU
- Hardware must have the following connections:
  - mic to MCU
  - RF stage to MCU, DC to ∼3kHz
  - MCU to speaker
  - *MCU to RF stage, DC to ∼3kHz*

M17 support

- First work done on the TYT MD-380, then extended to the MD-UV380
- Everything is handled in the MCU
- Hardware must have the following connections:
  - mic to MCU
  - RF stage to MCU, DC to ∼3kHz
  - MCU to speaker
  - MCU to RF stage, DC to ∼3kHz
- *Current limitations:*

M17 support

- First work done on the TYT MD-380, then extended to the MD-UV380
- Everything is handled in the MCU
- Hardware must have the following connections:
  - mic to MCU
  - RF stage to MCU, DC to ∼3kHz
  - MCU to speaker
  - MCU to RF stage, DC to ∼3kHz
- Current limitations:
  - *you need to mod the radio hardware*

M17 support

- First work done on the TYT MD-380, then extended to the MD-UV380
- Everything is handled in the MCU
- Hardware must have the following connections:
  - mic to MCU
  - RF stage to MCU, DC to ∼3kHz
  - MCU to speaker
  - MCU to RF stage, DC to ∼3kHz
- Current limitations:
  - you need to mod the radio hardware
  - *the MCU has to be powerful enough*

M17 support

- First work done on the TYT MD-380, then extended to the MD-UV380
- Everything is handled in the MCU
- Hardware must have the following connections:
  - mic to MCU
  - RF stage to MCU, DC to ∼3kHz
  - MCU to speaker
  - MCU to RF stage, DC to ∼3kHz
- Current limitations:
  - you need to mod the radio hardware
  - the MCU has to be powerful enough
  - *Codec2 uses floating point math*

Codeplug

- *Trying to make something which:*

Codeplug

- Trying to make something which:
  - *is open and free*

Codeplug

- Trying to make something which:
  - is open and free
  - *supports common ham radio needs (direct comm, repeaters, hotspots)*

Codeplug

- Trying to make something which:
  - is open and free
  - supports common ham radio needs (direct comm, repeaters, hotspots)
  - *is portable across devices, both for end users and developers*

Codeplug

- Trying to make something which:
  - is open and free
  - supports common ham radio needs (direct comm, repeaters, hotspots)
  - is portable across devices, both for end users and developers

- *Currently WIP, an RFC open at https://github.com/OpenRTX/openrtx.github.io/pull/32*

Codeplug

- Trying to make something which:
  - is open and free
  - supports common ham radio needs (direct comm, repeaters, hotspots)
  - is portable across devices, both for end users and developers
- Currently WIP, an RFC open at https://github.com/OpenRTX/openrtx.github.io/pull/32
- *Technical details:*

Codeplug

- Trying to make something which:
  - is open and free
  - supports common ham radio needs (direct comm, repeaters, hotspots)
  - is portable across devices, both for end users and developers
- Currently WIP, an RFC open at https://github.com/OpenRTX/openrtx.github.io/pull/32
- Technical details:
  - *binary format*

Codeplug

- Trying to make something which:
  - is open and free
  - supports common ham radio needs (direct comm, repeaters, hotspots)
  - is portable across devices, both for end users and developers
- Currently WIP, an RFC open at https://github.com/OpenRTX/openrtx.github.io/pull/32
- Technical details:
  - binary format
  - *up to 65'535 channels, contacts and banks (aka "zones")*

Codeplug

- Trying to make something which:
  - is open and free
  - supports common ham radio needs (direct comm, repeaters, hotspots)
  - is portable across devices, both for end users and developers
- Currently WIP, an RFC open at https://github.com/OpenRTX/openrtx.github.io/pull/32
- Technical details:
  - binary format
  - up to 65'535 channels, contacts and banks (aka "zones")
  - *currently supporting FM, DMR and M17 operating modes*

Codeplug

- Trying to make something which:
  - is open and free
  - supports common ham radio needs (direct comm, repeaters, hotspots)
  - is portable across devices, both for end users and developers
- Currently WIP, an RFC open at https://github.com/OpenRTX/openrtx.github.io/pull/32
- Technical details:
  - binary format
  - up to 65'535 channels, contacts and banks (aka "zones")
  - currently supporting FM, DMR and M17 operating modes
- *May become a separate entity from the firmware*

What's next

- *Firmware side:*

What's next

- Firmware side:
  - *Codeplug!*

What's next

- Firmware side:
  - Codeplug!
  - *Event system*

What's next

- Firmware side:
  - Codeplug!
  - Event system
  - *APRS support*

What's next

- Firmware side:
  - Codeplug!
  - Event system
  - APRS support
  - ...

What's next

- Firmware side:
  - Codeplug!
  - Event system
  - APRS support
  - ...

- *Hardware side:*

What's next

- Firmware side:
  - Codeplug!
  - Event system
  - APRS support
  - ...
- Hardware side:
  - *M17's OpenHT*

What's next

- Firmware side:
  - Codeplug!
  - Event system
  - APRS support
  - ...

- Hardware side:
  - M17's OpenHT
  - *Baofeng DM-1701 (can do M17!)*

What's next

- Firmware side:
  - Codeplug!
  - Event system
  - APRS support
  - ...
- Hardware side:
  - M17's OpenHT
  - Baofeng DM-1701 (can do M17!)
  - *Yaesu FT-70 and "sisters"*

What's next

- Firmware side:
  - Codeplug!
  - Event system
  - APRS support
  - ...
- Hardware side:
  - M17's OpenHT
  - Baofeng DM-1701 (can do M17!)
  - Yaesu FT-70 and "sisters"
  - ...

Happy hacking!

https://openrtx.org

https://mastodon.radio/@openrtx

https://matrix.to/#/#openrtx:matrix.org