TangerineSDR
Data Engine
and
Overall Architecture

Scotty Cowling, WA2DFI

HamSCI Workshop, University of Scranton
March 20, 2020
What is a TangerineSDR radio?

A TangerineSDR radio:

- Satisfies numerous use-cases, from space science to general amateur use to academic research
- Has wide-range cost-based performance
  - From $300 to $1000+ (typical ~$500)
- Is based upon an open source model (OHL/NCL hardware, GPL software)
- Advances the State of the Radio Art
A TangerineSDR radio has the following features:

- Small footprint, reasonably low power consumption
- Extremely modular, configurable and expandable
- Simple web-based User Interface
- Local display
- Built-in networking interface to data cloud
System Architecture

Target Applications (Use Cases)

- HamSCI Personal Space Weather Station (PSWS)
- Phase 4 Satellite Ground Station (P4G)
- Academic uses to teach SDR and FPGA techniques
- Amateur Communications SDR
- Experimenters’ (Amateur and non-Amateur) SDR
- Remote Ham Radio
- Others?
System Architecture

General Amateur User Benefits

- PSWS should provide some amateur radio features
- Easy to use local Web interface
- Propagation information (WSPRnet, RBN)
- Built-in digital modes (FT8)
- Ability to monitor digital modes concurrently with PSWS data acquisition
- Multiple bands simultaneously
- Special features, such as e-mail notification of heard station(s)
Personal Space Weather Station

Server Data Engine
- 50K LE FPGA
- 5Gb/s USB 3.0
- 2x GbE

Internet

HamSCI Public Database

Client Computer
(Single Board or Desktop)
- Local User Display(s)
- Local Data Storage
- Local Data Reduction
- Processed Data to HamSCI Servers

Mid-grade RX
- Dual 14b ADC
  - 122.88Msps

Magnetometer
- I2C
- SPI
- UART

© 2020 Scotty Cowling WA2DFI
So What Are We Going to Build?
TANGERINE SDR System Architecture

DATA ENGINE
- RF MODULE 0
- RF MODULE 1
- FPGA
- 3-PORT GbE SWITCH
- CLOCK MODULE

SINGLE BOARD COMPUTER
- ODROID N2
- RPi 3B+
- GbE

INTERNET VIA LOCAL NETWORK

REV XA1
If you can’t dazzle them with brilliance, baffle them with bull.

--W.C. Fields

If you can’t baffle them with bull, dazzle them with details.

--WA2DFI
Hardware Features

TANGERINE SDR

DATA ENGINE

RF MODULE 0
RF MODULE 1

CLOCK MODULE

FPGA

3-PORT GbE SWITCH

INTERNET VIA LOCAL NETWORK

SINGLE BOARD COMPUTER

ODROID N2
RPi 3B+

GbE

TangerineSDR System
Hardware Features

TangerineSDR DE Features

- Altera/Intel 10M50DAF672C6G FPGA 50K LEs
- 512MByte (256Mx16) DDR3L SDRAM
- 4Mbit (512K x 8) QSPI serial flash memory
- 512Kbit (64K x 8) serial EEPROM
- μSDXC memory card up to 2TByte
Hardware Features

TangerineSDR DE Features

- 11-15V wide input, low noise SMPS
- 3-port GbE Switch (Dual GbE data interfaces)
- Cryptographic processor with key storage
- Temperature sensors (FPGA, ambient)
- Power-on reset monitor, fan header
TANGERINE SDR

DATA ENGINE

- RF MODULE 0
- RF MODULE 1
- FPGA
- 3-PORT GbE SWITCH
- CLOCK MODULE

SINGLE BOARD COMPUTER

- ODROID N2
- RPi 3B+
- GbE

INTERNET VIA LOCAL NETWORK

TangerineSDR System
Hardware Features

TangerineSDR RF Modules

- Two 140-pin MEC RF Module (RFM) sockets (up to 1.5GB/s)
  - One TX and one RX RFM or
  - Two RX RFMs or
  - One double-wide TRX RFDM
Hardware Features

TangerineSDR PSWS/HF RX Module

- AD9648-125 dual 14-bit 122.88Msps ADC
- 0dB/10dB/20dB/30dB remotely switchable attenuator
- LTC6420-20 20dB LNA
- Fixed 55MHz Low Pass Filter
- Optional user-defined plug-in filter
- On-board, switchable 50-ohm calibration noise source
- On-board low-noise power supplies
- Dual SMA antenna connectors
Hardware Features

TangerineSDR PSWS/HF RX Module

[Diagram showing hardware features of the TangerineSDR PSWS/HF RX Module, including connections and components such as AD9648-125, LT6420-20, and various filters and voltages.]
Hardware Features

Future Tangerine SDR RF Modules

- P4G RX and P4G TX modules or P4G TRX single module
- AD9361 MIMO transceiver module (70MHz – 6GHz)?
- Lime LMS7002M SDR Module (100kHz – 3.8GHz)?
- Lime LMS8001+ SDR Module (100kHz – 12GHz)?
Hardware Features

TangerineSDR RF Modules

Tom McDermott, N5EG will provide more detail on the PSWS RF Module later this morning

Special thanks to Tom for lending us his RF expertise to make this exceptional RF module
TANGERINE SDR

DATA ENGINE

- RF MODULE 0
- RF MODULE 1
- FPGA
- 3-PORT GbE SWITCH

CLOCK MODULE

SINGLE BOARD COMPUTER

- ODROID N2
- RPi 3B+
- GbE

INTERNET VIA LOCAL NETWORK

TangerineSDR System
Yes, we have no Clock Modules

- On-board, lowest cost TCXO (e.g., Rakon RTX5032A)
  - Adequate performance for most applications
  - Lowest cost
  - Eliminates need for Clock Module
Hardware Features

TangerineSDR Clock Modules

- Clock Module Socket (M.2) for Improved Performance
  - High performance VCXO (e.g., Crystek CVHD-950)
  - Extreme performance OCXO
  - Entry-level GPSDO (LEA-M8F?)
  - High-Performance GPSDO (Jackson Labs LTE Lite?)
  - Others, as required?

A work in progress at this time.
Tangerine SDR Clock Module

Diagram by N8UR

http://hamsci.org
Hardware Features

TangerineSDR Clock Modules

John Ackermann, N8UR will provide more detail on the GPSDO Clock Module later this morning.

Special thanks to John for taking on the CKM design.
Hardware Features

Proposed Modular Solution

DATA ENGINE

GbE
GbE
USB 3.0
MEC
140
MEC
140
RF
MEC
80

RK Pi HAT

SBC

Hi SPD

LO SPD

© 2020 Scotty Cowling WA2DFI
Hardware Features

DE Communications

- GbE
- SBC
- CKM
- GbE
- USB 3.0
- MEC 140
- MEC 140
- MEC 80
- RF

TSDR LEAF

RPi HAT

HI SPD
LO SPD
Hardware Features

TangerineSDR DE Communications

- 5Gbps USB 3.0 device interface (up to 500MB/s)
  - High-speed PC interface
- 480Mbps USB 2.0 host interface (up to 50MB/s)
  - for DVB dongle
- Dual GbE RJ45 ports (aggregate 100MB/s)
  - One for SBC, one for external network
Hardware Features

DE I/O Expansion

DATA ENGINE (DE)

GbE
CKM
GbE
USB 3.0
MEC 140
MEC 140
MEC 80
RF
RF

SBC

TSDR LEAF

RPi HAT

HI SPD
LO SPD
Hardware Features

TangerineSDR DE I/O Expansion

- GPIO for sensor and shield interfaces
- Dual connectors for both low/high speed expansion
  - Standard Raspberry Pi Hat low-speed connector
  - TangerineSDR LEAF high-speed connector
- Connectors for PTT, Keyer Paddle, PA Key
LEAF

Low-speed Expansion Adapter Fixture

40-pin RPi
LOW-SPEED

RPi HAT

75-pin TSDR M.2
HIGH-SPEED

TSDR LEAF
Hardware Features

Supported Expansion

- RPi Hat - Low Speed (Direct Support)
- TangerineSDR LEAF - Low/High Speed
- Other Low Speed Using LEAF
  - Arduino Shield
  - Beagle Board Cape
  - Click modules
  - PMOD (I2C/SPI/UART)
  - Ultra96 high-speed expansion port
  - Others
Hardware Features

Future TangerineSDR DE Boards

- Larger, faster FPGAs
- More DRAM storage
- More non-volatile (SATA, SSD, etc) storage
- Higher speed data ports (10GE, 40GE, USB 3.2, etc)

BUT…

The same RFM and CKM ports allow reuse of RF and Clock boards
When can I get one?

RFM
- Prototypes by mid-May
- Production by DCC (mid Sept)

DE
- Prototypes by June
- Production by DCC (mid Sept)

CKM
- Prototypes by DCC (mid Sept)
- Production by mid December
Our Web Page

TangerineSDR.com
E-mail Listserv

Post:
TangerineSDR@lists.tapr.org

Subscribe:
lists.tapr.org/mailman/listinfo/
Teamspeak 3 Chat

Teamspeak.TangerineSDR.com:7388

Monday Evenings, 2100EDT
(0100Z Tuesday)
Thank you!

WA2DFI@ARRL.NET

TangerineSDR.com

Teamspeak.TangerineSDR.com:7388