TangerineSDR Data Engine and Overall Architecture

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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

What is a TangerineSDR radio?

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)

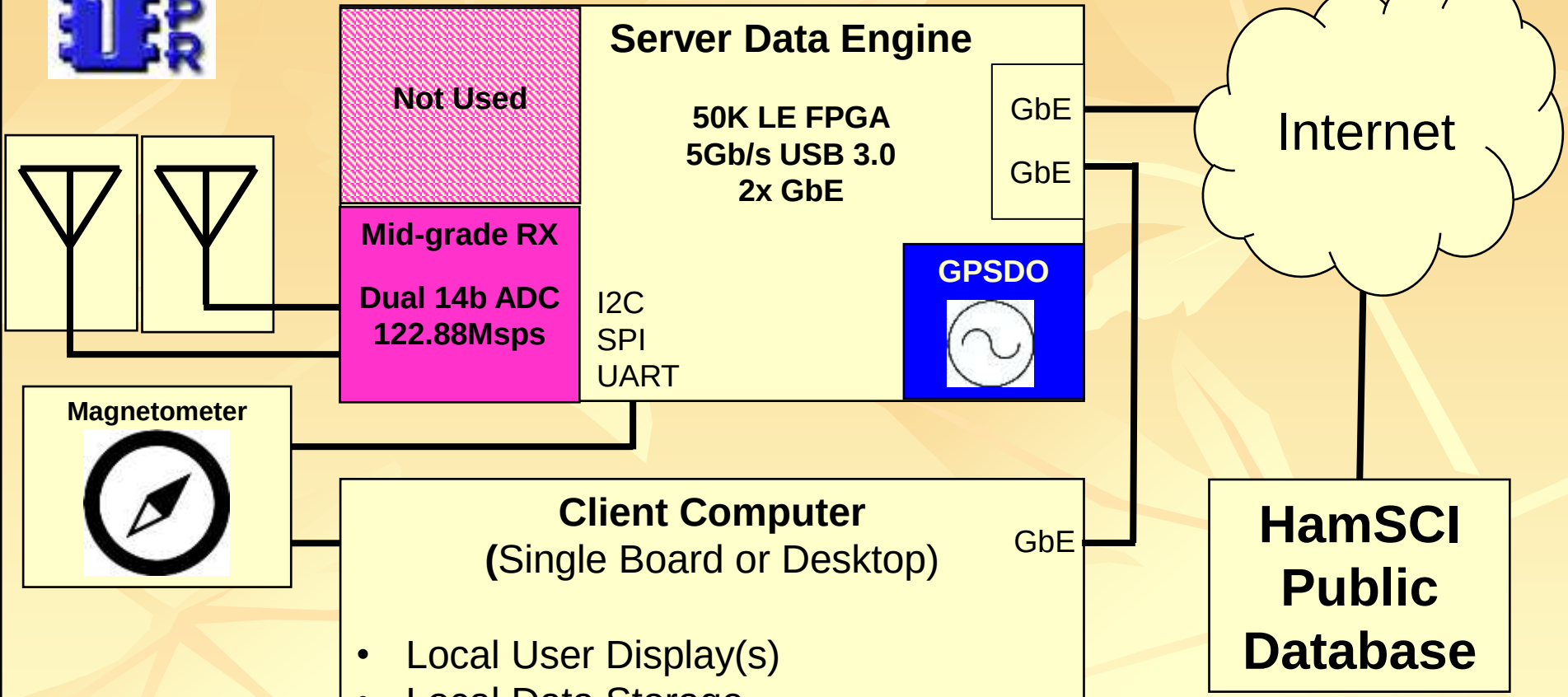
- HamSCI Personal Space Weather Station (PSWS)
- Phase 4 Satellite Ground Station (P4G)
- Academic uses to teach SDR and FPGA techniques
- Amateur Communications SDR
- Experimenters' (Amateur and non-Amateur) SDR
- Remote Ham Radio
- Others?

System Architecture

General Amateur User Benefits

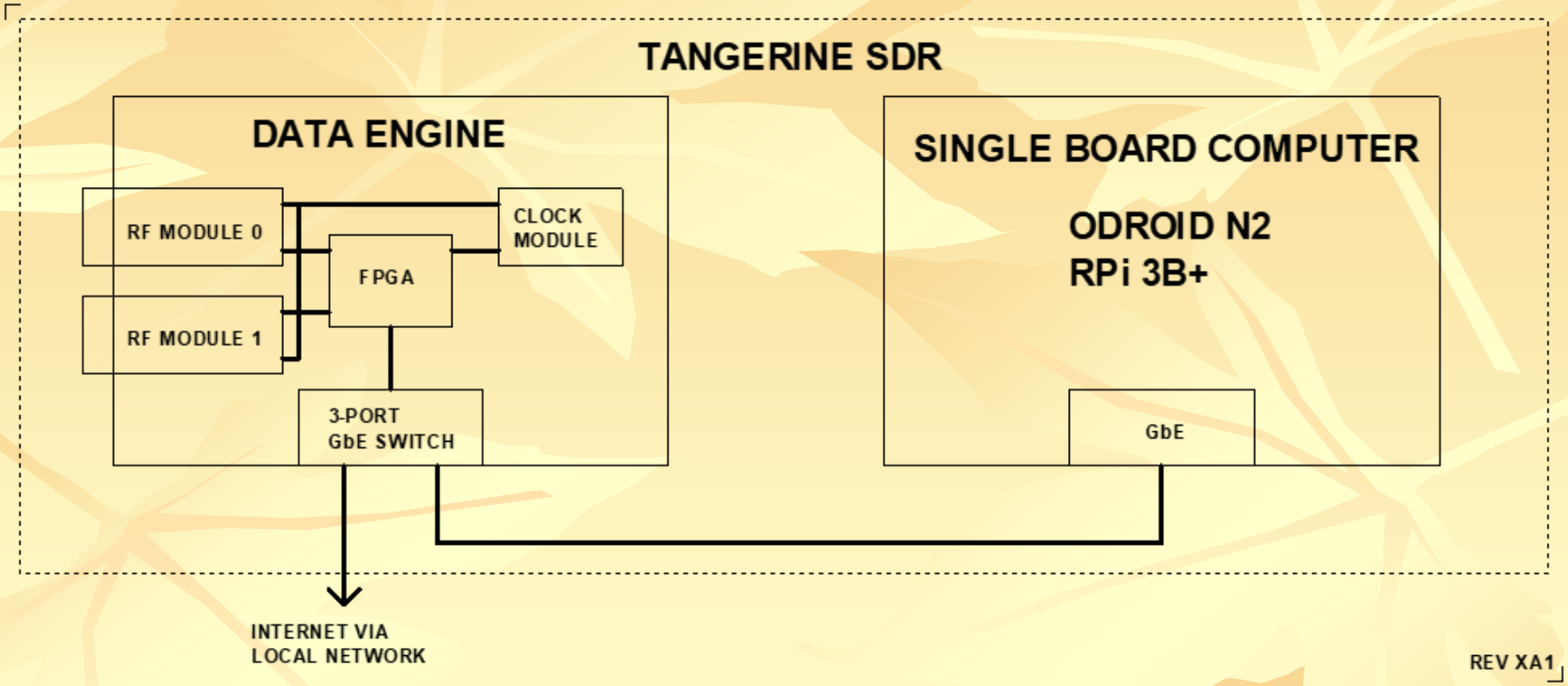
- PSWS should provide some amateur radio features
- Easy to use local Web interface
- Propagation information (WSPRnet, RBN)
- Built-in digital modes (FT8)
- Ability to monitor digital modes concurrently with PSWS data acquisition
- Multiple bands simultaneously
- Special features, such as e-mail notification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

Personal Space Weather Station



So What Are We Going to Build?

System Architecture



TangerineSDR System

Aphorism, Adage, Proverb?

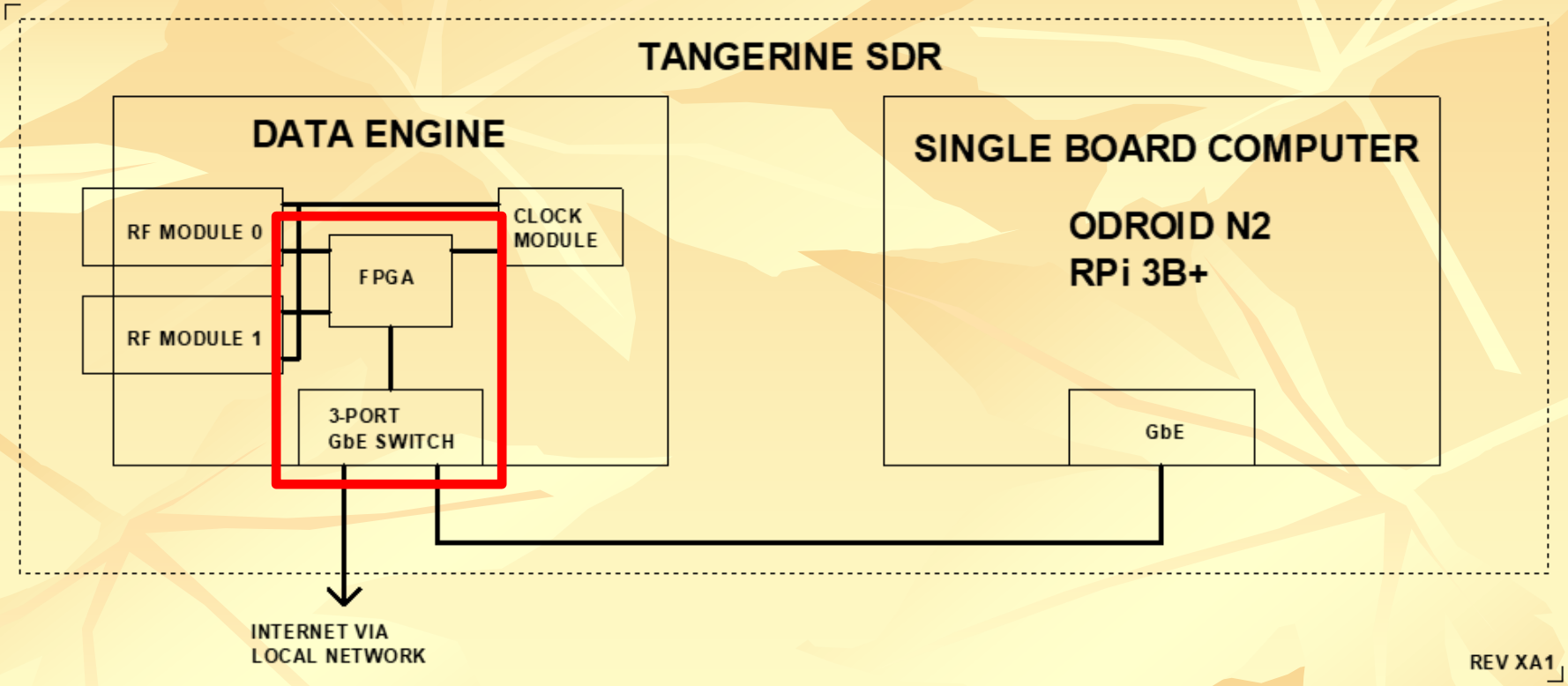
If you can't dazzle them with brilliance, baffle them with bull.

--W.C. Fields

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

--WA2DFI

Hardware Features



TangerineSDR System

Hardware Features

TangerineSDR DE Features

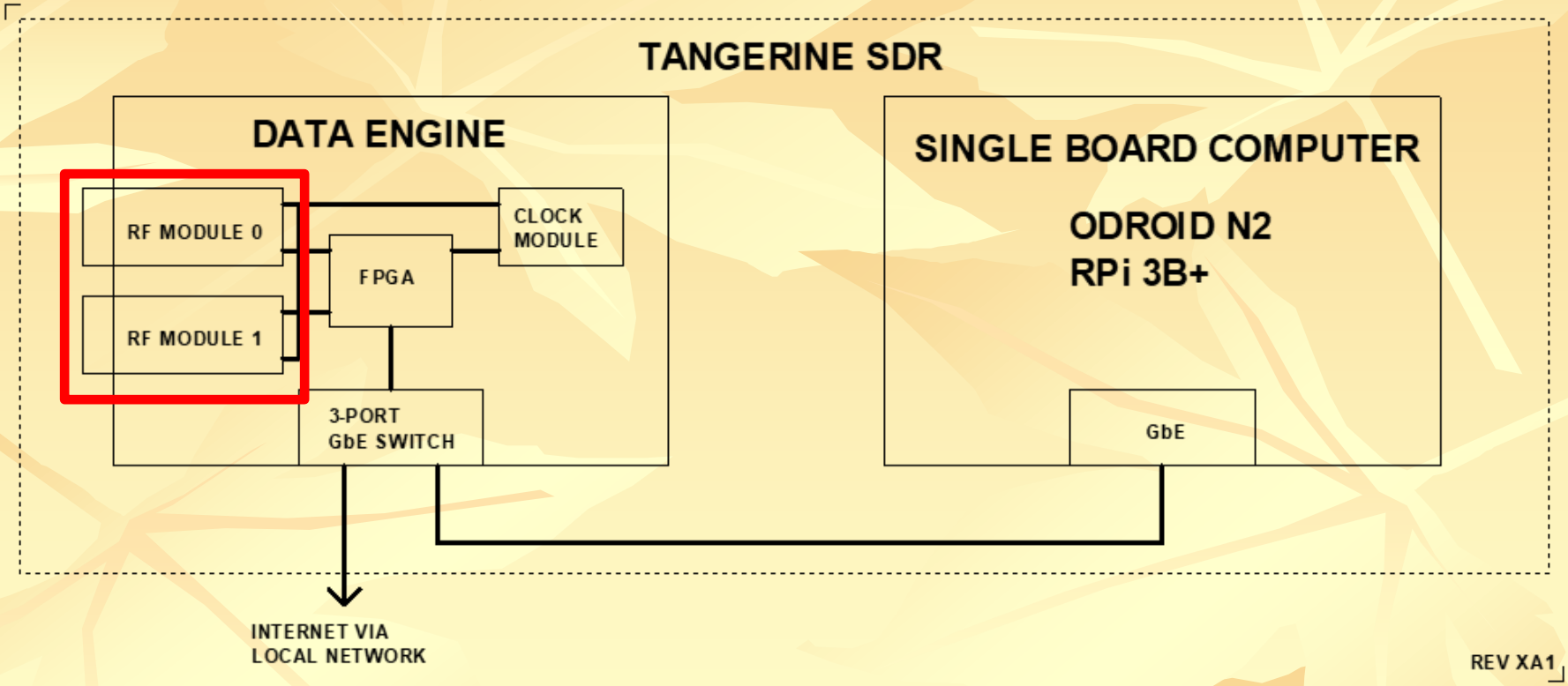
- Altera/Intel 10M50DAF672I6G FPGA **50K LEs**
- 512MByte (256Mx16) DDR3L SDRAM
- 4Mbit (512K x 8) QSPI serial flash memory
- 512Kbit (64K x 8) serial EEPROM
- µSDXC memory card up to 2TByte

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

Hardware Features



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

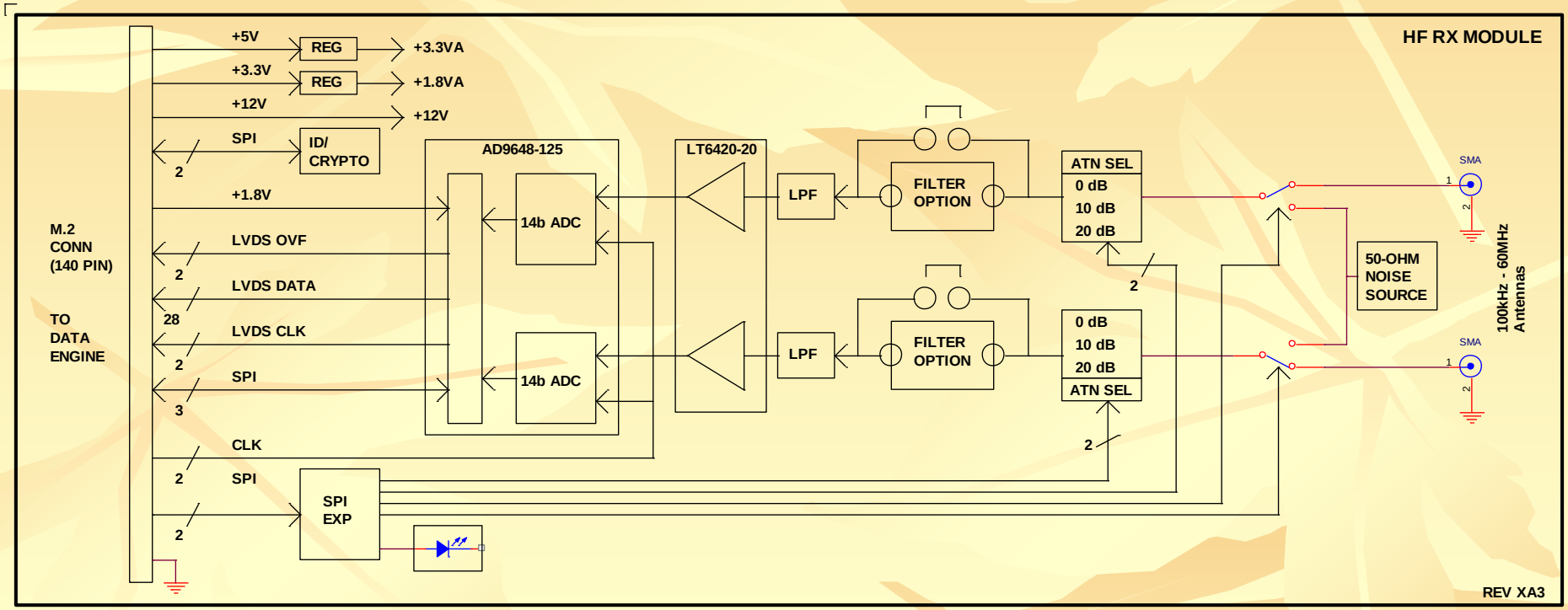
Hardware Features

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



Hardware Features

Future TangerineSDR RF Modules

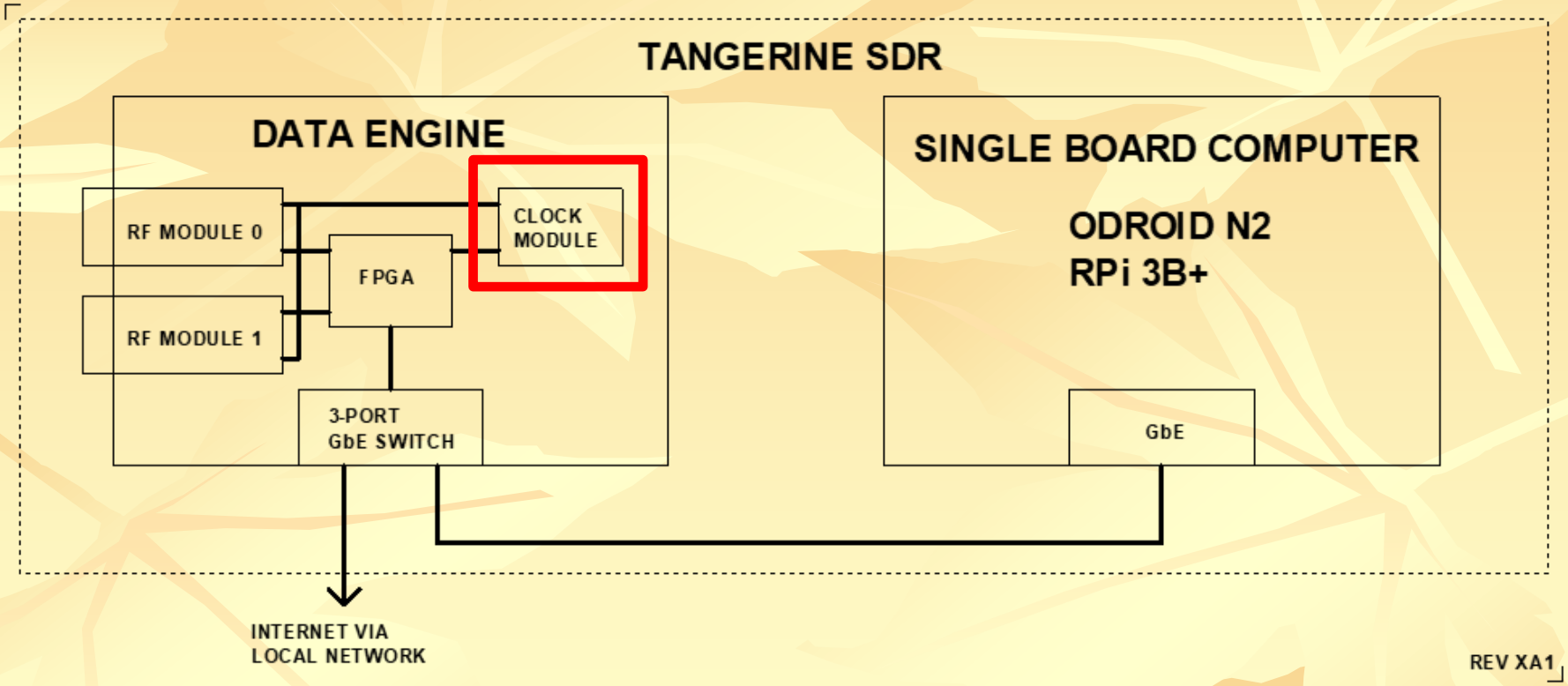
- P4G RX and P4G TX modules **or** P4G TRX single module
- AD9361 MIMO transceiver module (70MHz – 6GHz)?
- Lime LMS7002M SDR Module (100kHz – 3.8GHz)?
- Lime LMS8001+ SDR Module (100kHz – 12GHz)?

Hardware Features

TangerineSDR RF Modules

Special thanks to Tom McDermott, N5EG for lending us his RF expertise to make this exceptional RF module

Hardware Features



TangerineSDR System

Hardware Features

Yes, we have no Clock Modules

- On-board, lowest cost TCXO
  - Adequate performance for most applications
  - Lowest cost
  - Eliminates need for Clock Module

Hardware Features

TangerineSDR *SynthDO* Clock Module

- *SynthDO* Clock Module for Improved Performance
  - High performance TCXO (e.g., Rakon RPT7050A)
  - Squaring/anti-jitter circuitry (LTC-6957)
  - High performance synthesizer/multiplier (Si5345A)
  - Three GPS options
    - High-Performance GPS (Ublox ZED-F9T: ~$190)
    - Mid-performance GPS (Ublox NEO-M8T: ~$50)
    - Entry-level GPS (Ublox Neo-M9N: ~$15)
  - Interface board to use CKM as lab instrument (coming soon)

TangerineSDR Clock Module

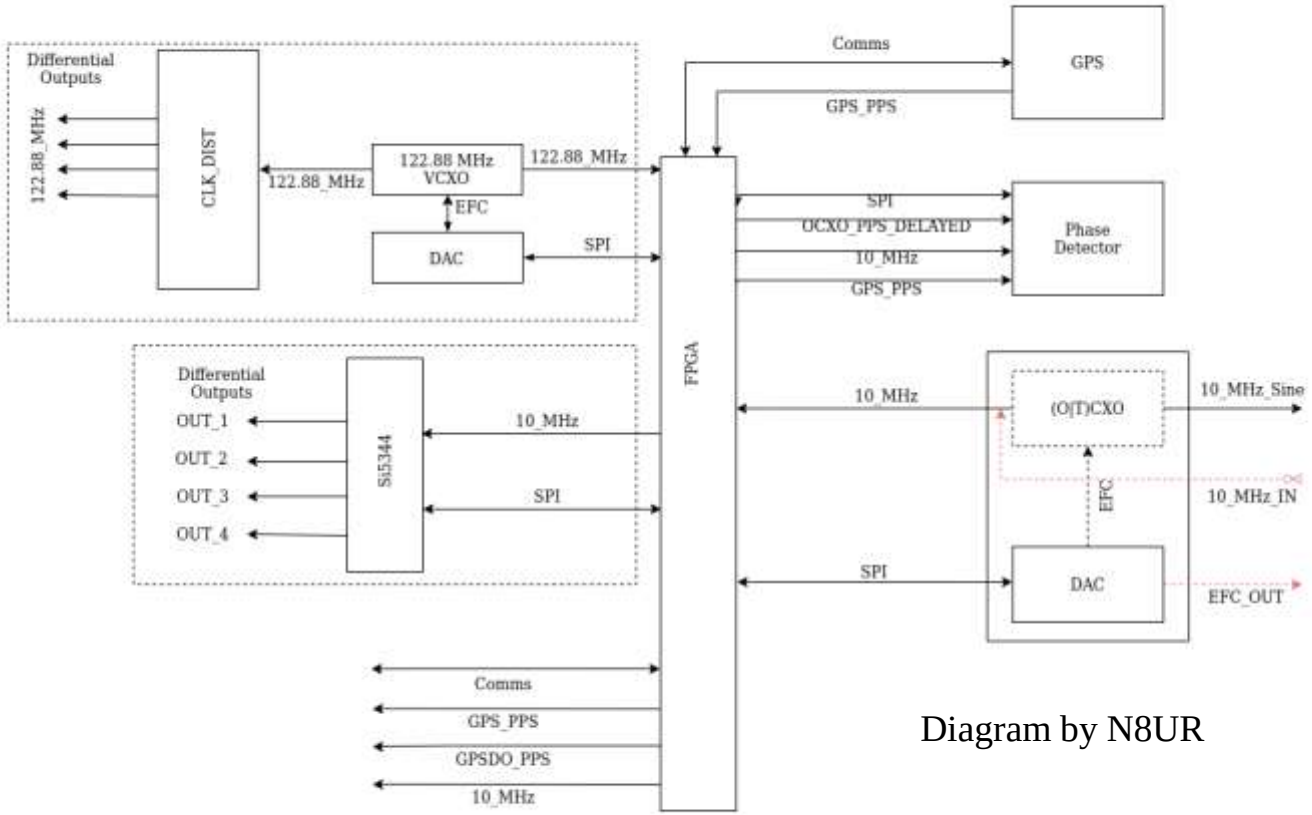


Diagram by N8UR

Original Design

TangerineSDR Clock Module

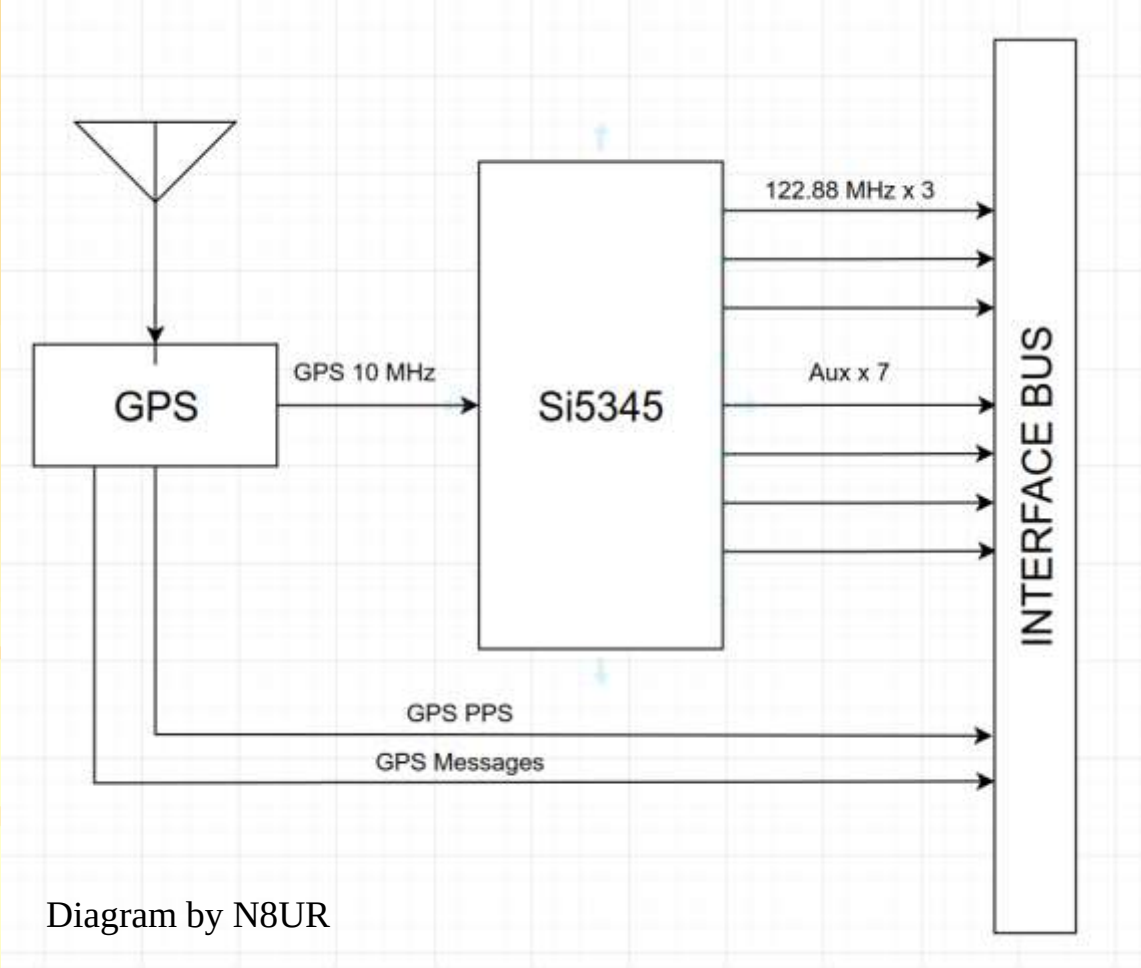
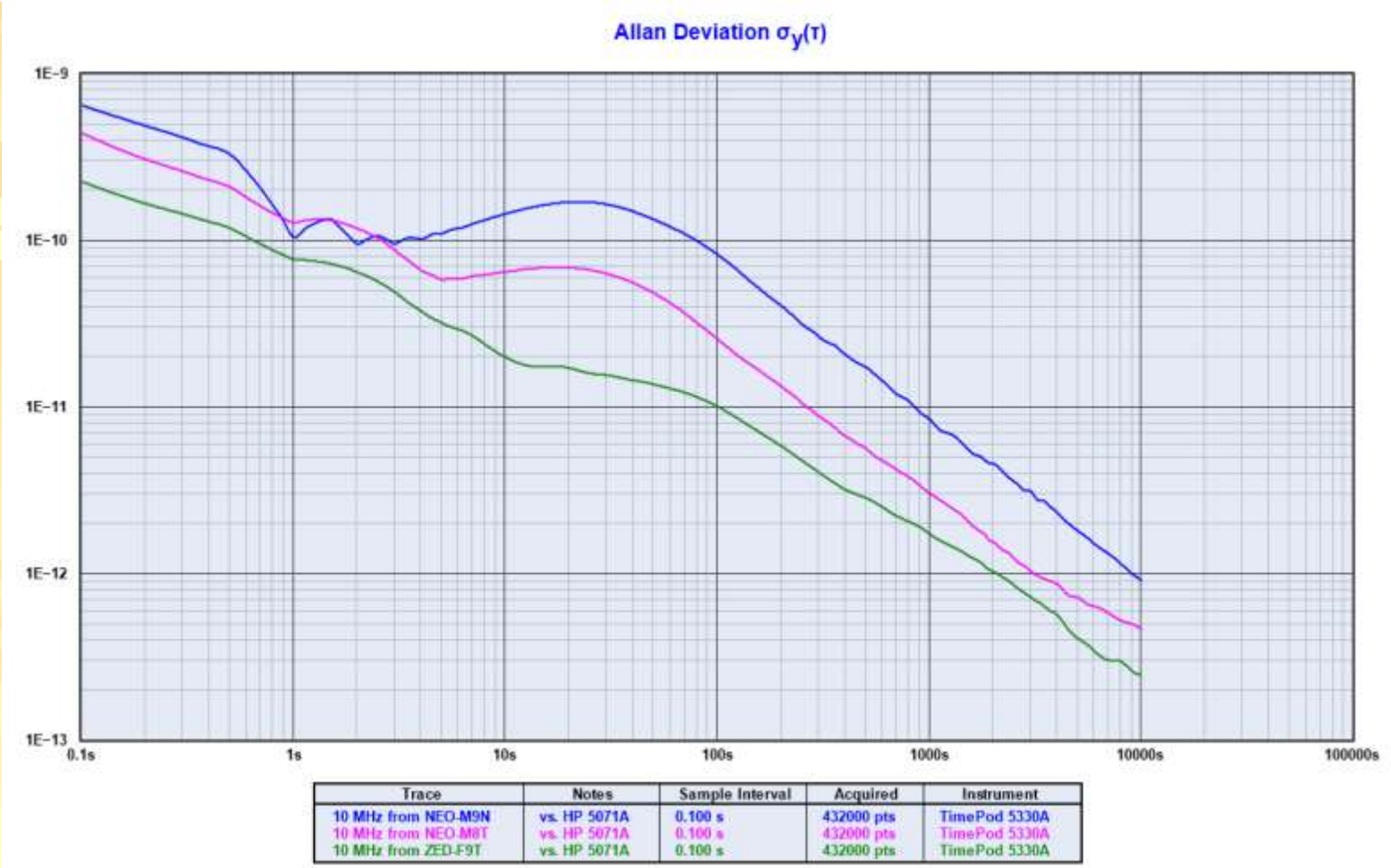


Diagram by N8UR

Final Design

TangerineSDR Clock Module



Trace	Notes	Sample Interval	Acquired	Instrument
10 MHz from NEO-M9N	vs. HP 5071A	0.100 s	432000 pts	TimePod 5330A
10 MHz from NEO-M8T	vs. HP 5071A	0.100 s	432000 pts	TimePod 5330A
10 MHz from ZED-F9T	vs. HP 5071A	0.100 s	432000 pts	TimePod 5330A

uBLOX GPS Receiver 10MHz Performance

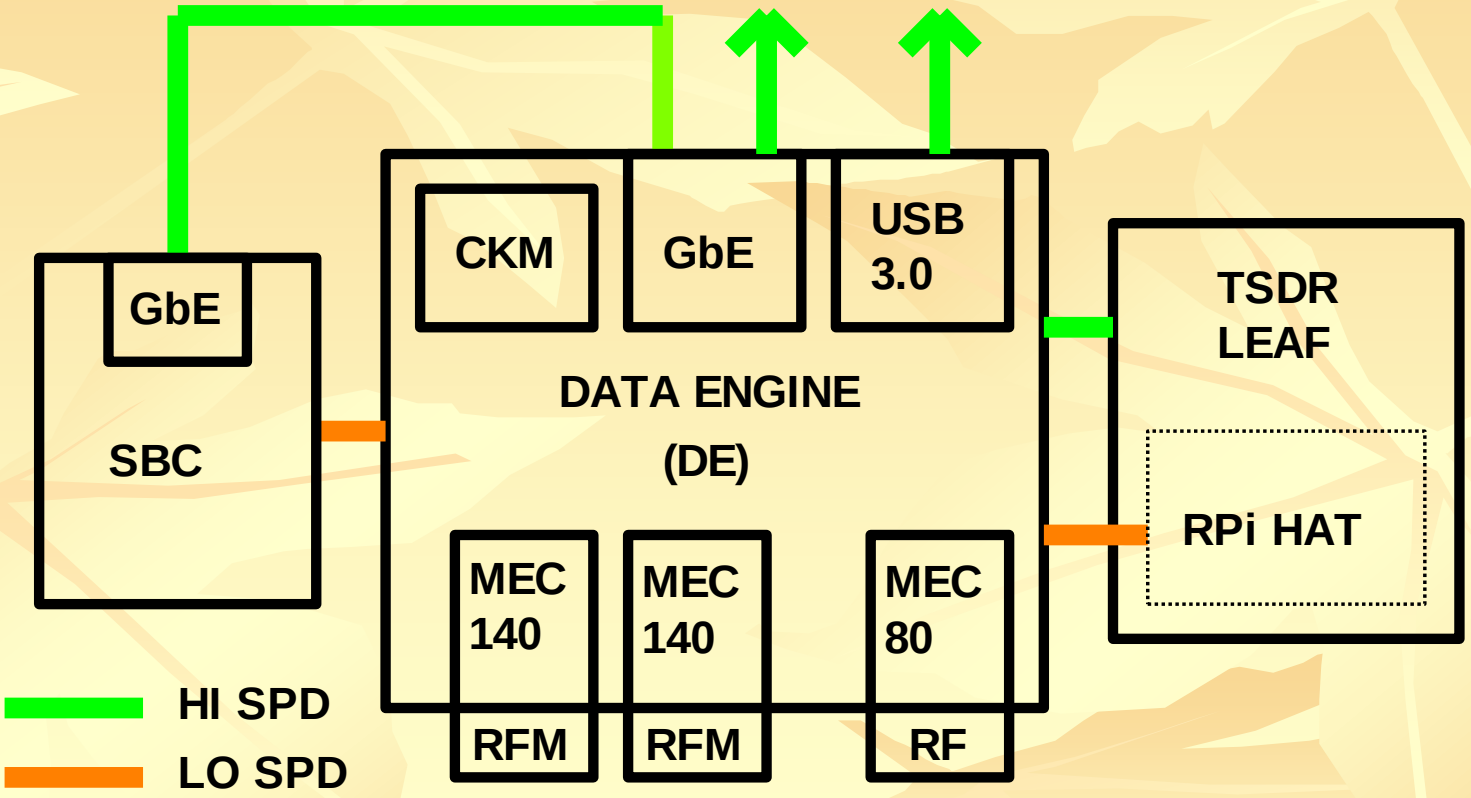
Hardware Features

TangerineSDR Clock Module

Special thanks to John Ackermann, N8UR for taking on the CKM design.

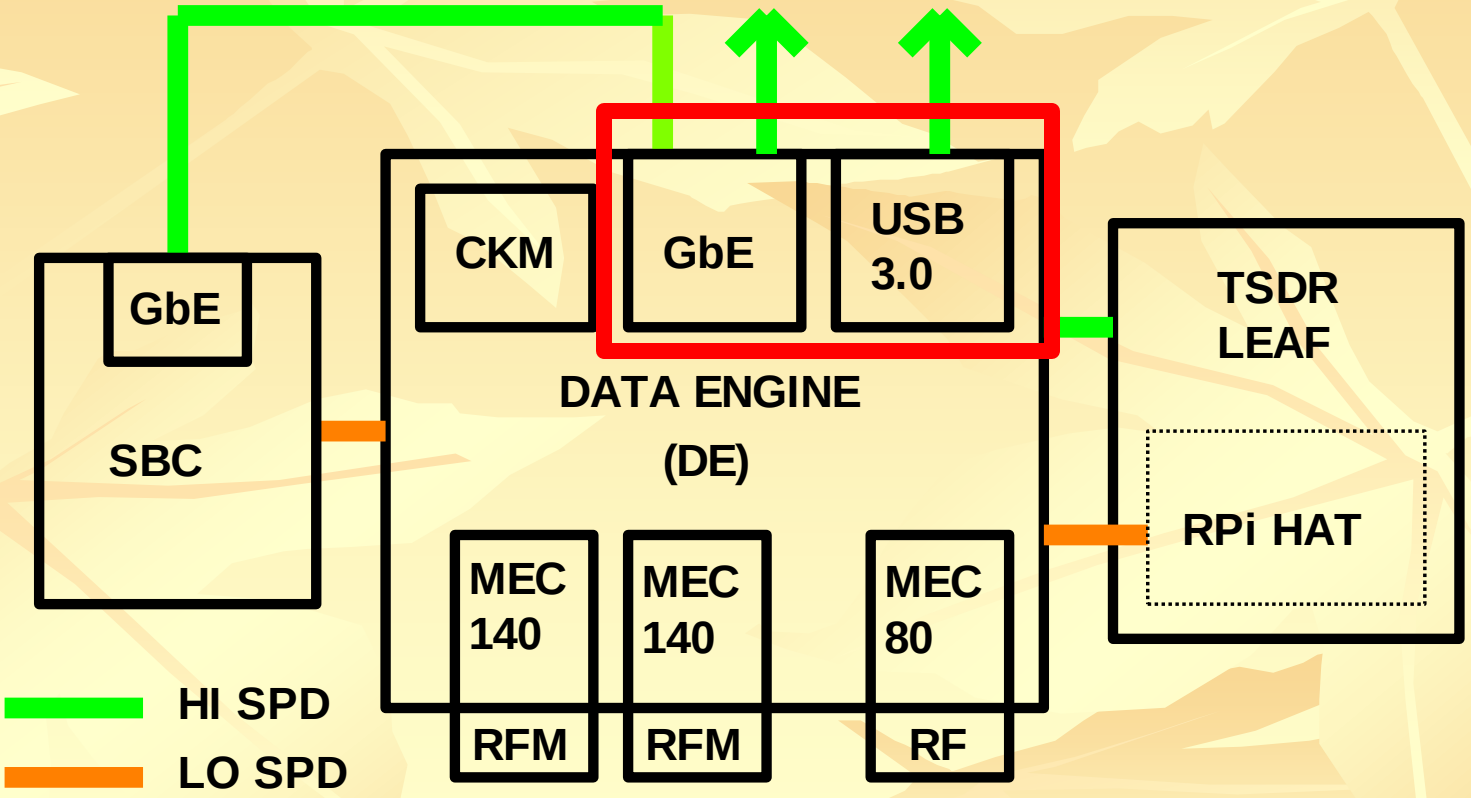
Hardware Features

Proposed Modular Solution



Hardware Features

DE Communications



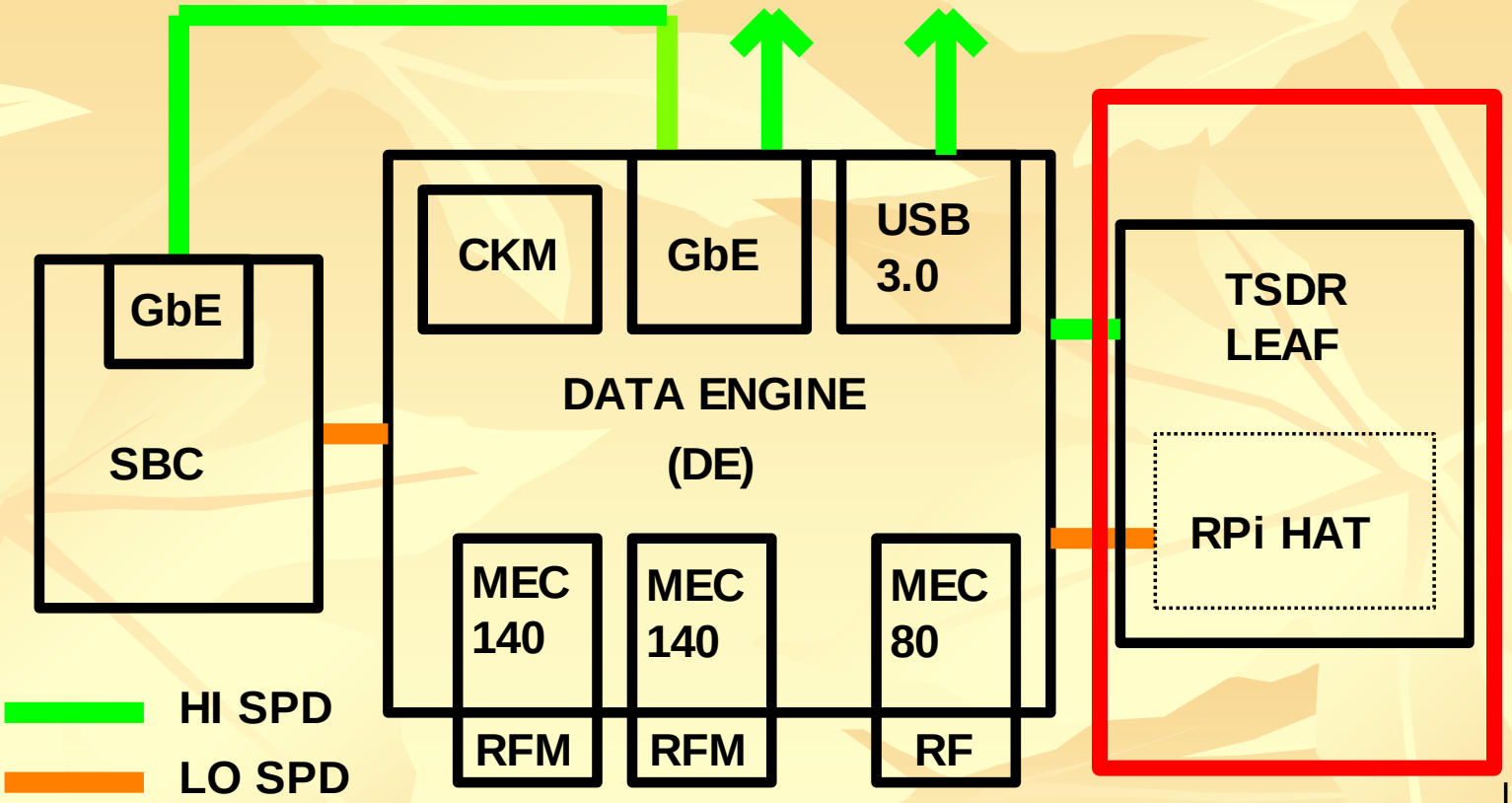
Hardware Features

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



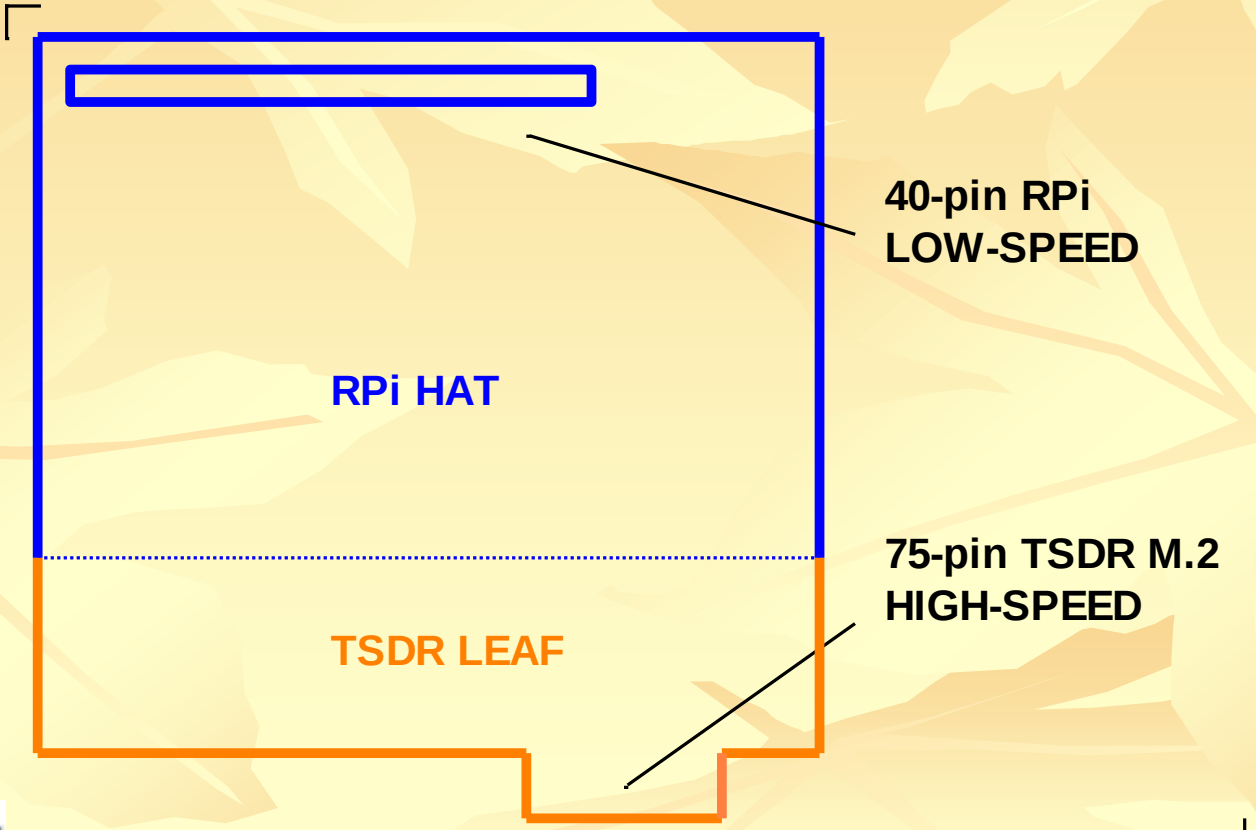
Hardware Features

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



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

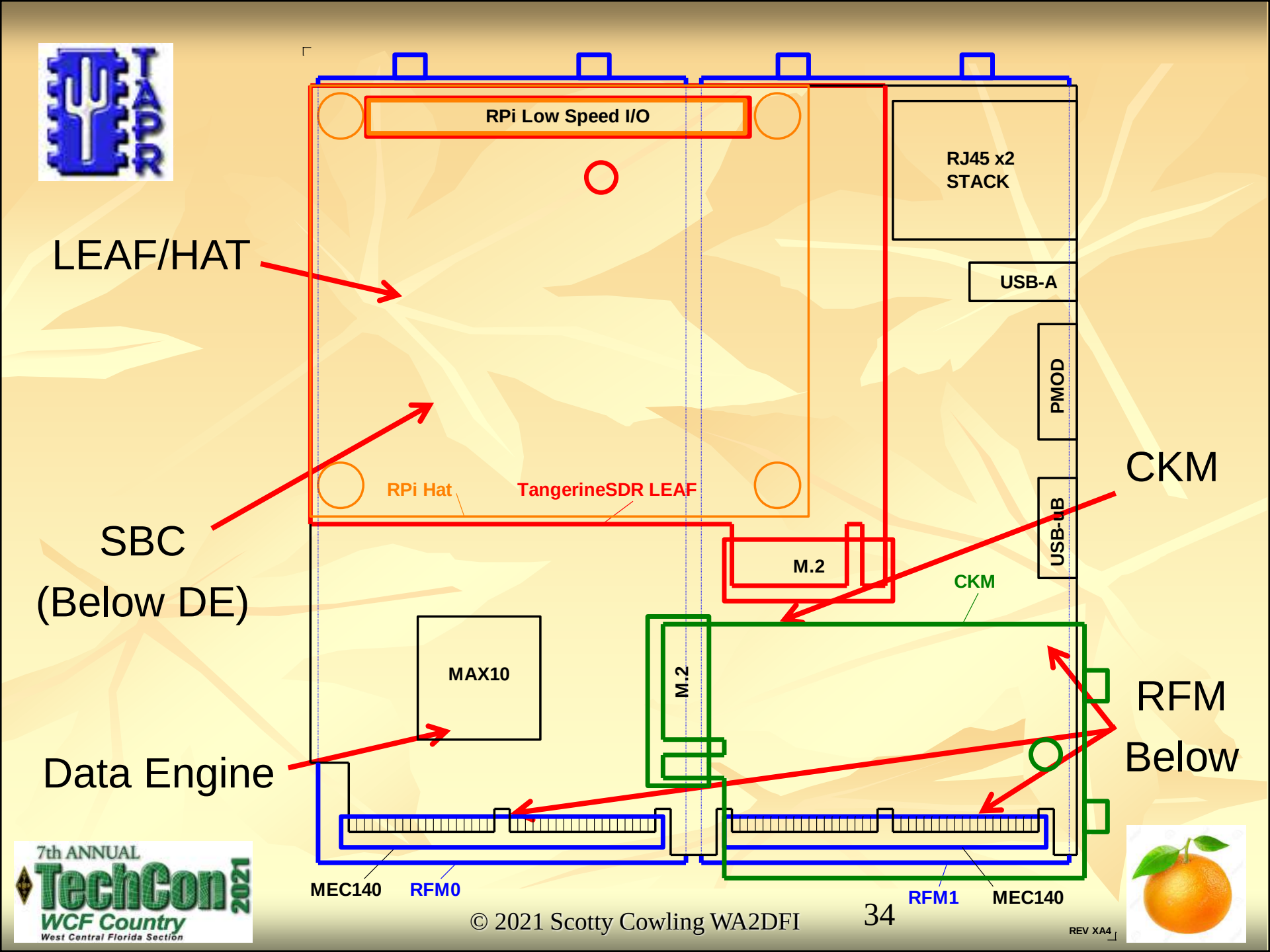
Hardware Features

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



How Far Along Are We?

RFM

- Schematic/BOM complete
- PCB layout/design complete
- Awaiting DE layout to confirm integration
- Ready for prototype build

How Far Along Are We?

DE

- Schematic/BOM complete
- Currently in PCB layout/design

How Far Along Are We?

CKM

- Testing of P.O.C. using development boards complete
- Many revisions and simplifications made
- Schematic about 80% complete
- BOM complete

When can I get one?

RFM

- Prototypes by mid-May 2021
- Production by September 2021

DE

- Prototypes by mid-May 2021
- Production by September 2021

CKM

- Prototypes by mid May 2021
- Production by September 2021

Our Web Page

TangerineSDR.com

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