001-365 • WK 01

1 JAN MON

BT

DEC '23

S	M	T	W	T	F	S
31					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

Direction Finding:

- 5.1 → hallmark feature
- positioning solution based on direction of signal using phase detection.

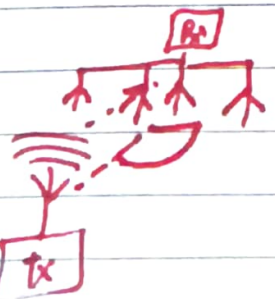
⇒ Positioning Systems → RTLS
→ Indoor positioning

⇒ Proximity sols: → Proximity marketing
→ item finding

→ Bluetooth host QDID: tag 2.1.0 → direction finding
→ Softdevice QDID: tag 2.0.0 - AoA txer
→ Zephyr Controller QDID: tag 2.1.0 Zephyr support

AoA & AoD RSSI (reduced)

⇒ AoA (1 mobile & 1 static device)
→ I/Q data needed
Static → large, multiple antenna (array) (Rx)
mobile → small, single antenna (: Tx)



→ cdc - angle of received signal

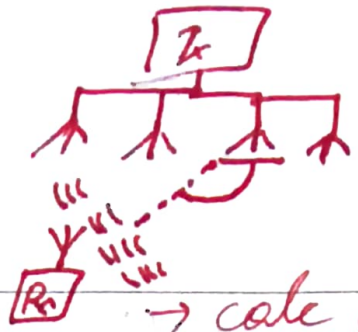
2024

FEB '24

M	T	W	T	F	S	S
			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29			

WK 01 • 002-364

JAN / TUE 2



→ calc angle of dxd signal

AoD

Tx → advised beacon, ant. array & RF switches req.
No I/Q calcs., medium cost & LPC

Rx → Single ant.; I/Q calc for CTE estimation
Processing pwr., high cost, HPC

Physics D.F ⇒ needs CTE

⇒ BT Packet:

LSB MSB

Preamble (1 or 2 octets	Access-Address (4 octets)	PDU 2-258 octets	CRC 3 octets	Constant Tone Extension 16 to 160 µs

- CTE → const- freq. signal for IQ sampling
- Unwhitened seq. of 1s (Tone) is appended to CRC
- Connection & Connectionless modes.
- 1 Mbit / 2 Mbit PHYs.
- CTE → allows phase shifts measurements
  → continuous comm. of '1' coming out of radio.

2024

003-363 • WK 01

3 JAN WED

I → in-phase signal

Q → phase-shifted signal

DEC 23

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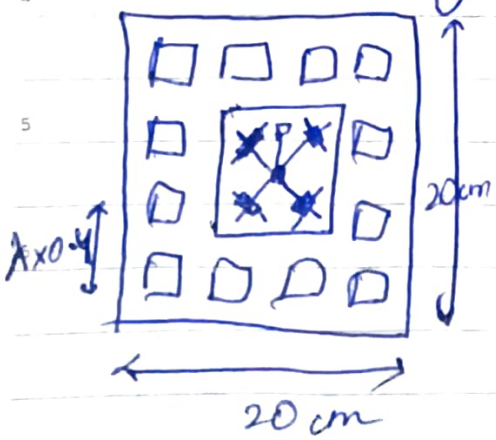
CTE & I/Q sampling

- CTE range = 16μs to 160μs.
- Min → 2 ant.
  max → 38/75 ant. (s
- Guard Period - at front → ant. may switch
- Reference Period at - end → Ref reference I/Q sample

Switch/Sample slots → 2μs or 1μs

ant. switching period → I/Q sampling period

⇒ Ant: Array: patch antennas: (Noob)



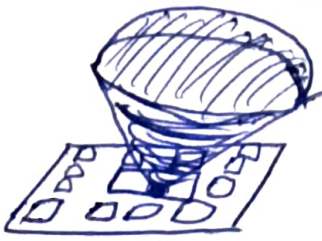
12 patch ant: High-perf. RF-switches

Array → 2 Cgks

Line → 1 Cgk

Design file: ISP1907-AOA-DK

2024



→ Rad. Pattern

20cm to mitigate Phase shift among sample references ⇒ Phase shift imperceptible

★ I/Q Samples:

I/Q → 90° P.S ; signal is demodulated with cosine.

I/Q data to phase & Amplitude.

$\theta = \arctan Q/I$

$A = \sqrt{I^2+Q^2}$ } Phasors

I/Q data should be 8-bit

⇒ Indicate signal in nRF devices.

→ saturated signal returns '128' according to BT spec.

BT specification:

→ Covers
- Host functionality
- HCI commands
- Over-air packet format
- Sample timing
- I/Q data format / CTE offending

Doesn't Cover.
- Ant. array design
- Algo. for calc. of AoA
- Exchange of ant. array data
- Locationing

5 JAN FRI

DEC 23

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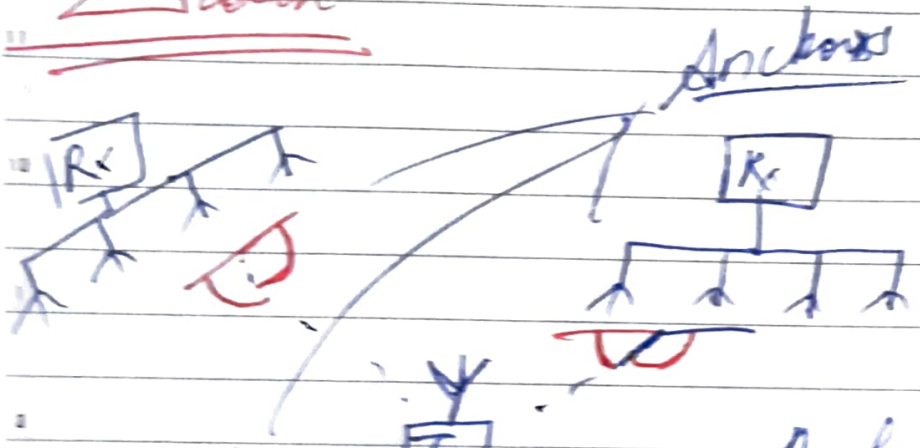
>> CTE can be appended only to pkts in data channels.

- periodic advertising for pkts with CTE

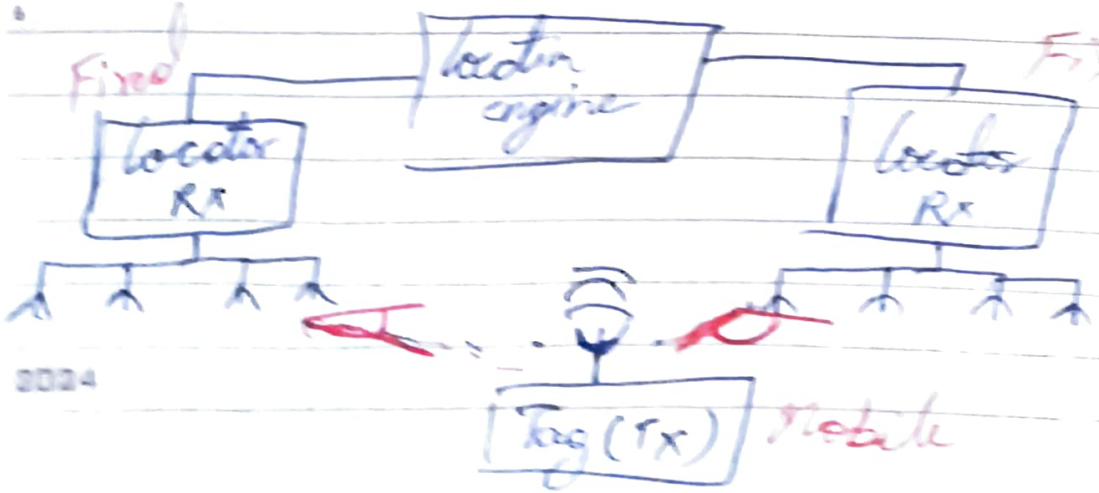
Location



Angle: Reading from one anchor point

Position: Reading from multiple A.P

Asset Tracking - RTLS



2024

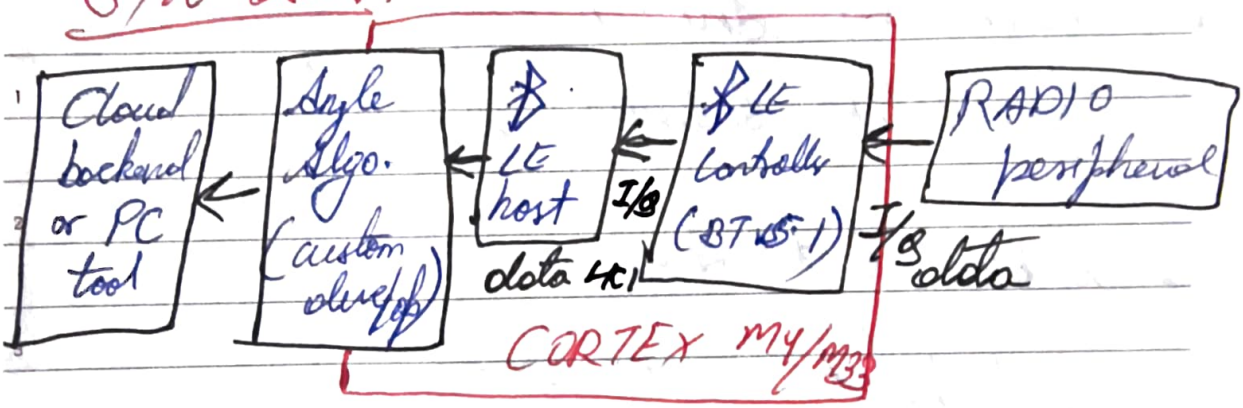
nRF Connect SDK samples:

Connectivity
→ locator
→ beacon

connected
→ locator
→ peripheral

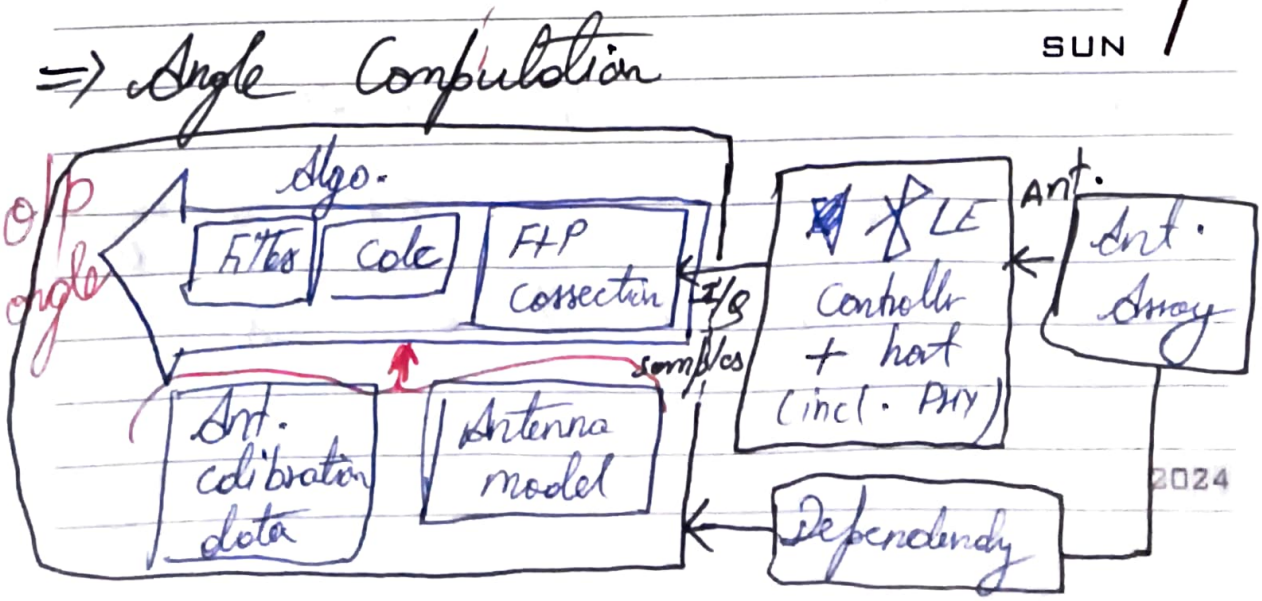
⇒ Locator:

S/W arch:



Customer code | nRF Connect SDK

⇒ Angle Computation



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5340

AoA & AoD Tx & Rx funality.

significant RAM needed for
→ caching calculation, tx off chip etc.

- Insight SiP Ant. Array supported
  →12 Patch Antenna Array.
- u-blox Ant. Array
  → 4 patch ant-array
  → complete solution
  	ap, algo, ant-design

•) (< 1m) sub-1m
Accuracy → depends on Ant. Array
Max. dist → b/w tag & array & X
→ depends
→ large dist. lower accuracy

NEXT

FEB '24

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WK 02 • 009-357

JAN 9 TUE

NRF
↓
u-blox
↓
Traxmote

XPLR - AOA - 1 → Directi Find
- 2 Indoor positioning
- 3 Anchor point ref.

9

10 ANT - B10 ant. board.
+ 8 patch ant, → 3D

11 EVB - ANT - 1 + + 1 RF switch

→ dev board

12

+ ANT - B11 ant. board
- 2D positioning

1

2

3

4

5

6

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10 JAN WED

DEC '23

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Used:

PC: Ubuntu

IDE: VS Code (+ VS Code nRF Connect Extension)

nRF Connect SDK (NCS) built on top of Zephyr RTOS

Build System: "west" (meta-tool for Zephyr & NCS)

Compiler Toolchain: GNU Arm Embedded Toolchain

Toolchain v3.0.2

SDK v3.0.2 (/home/ank/ncs/v3.0.2)

2024