OFDMA Backscatter: Boosted Capacity Low Power IoT System

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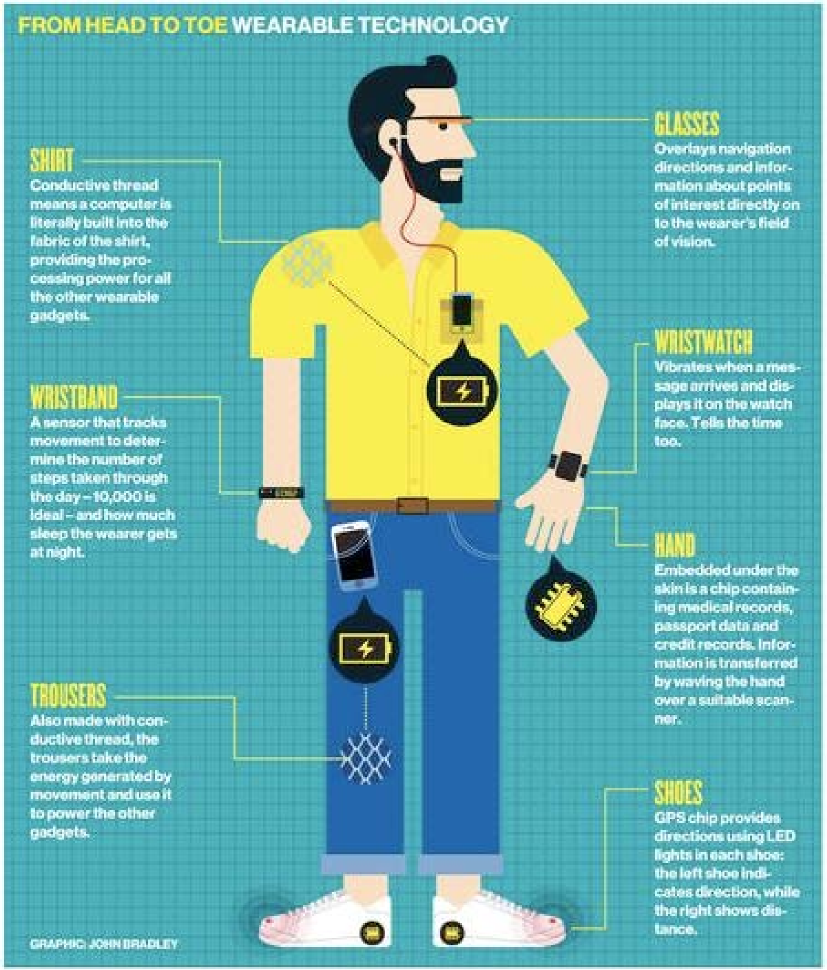
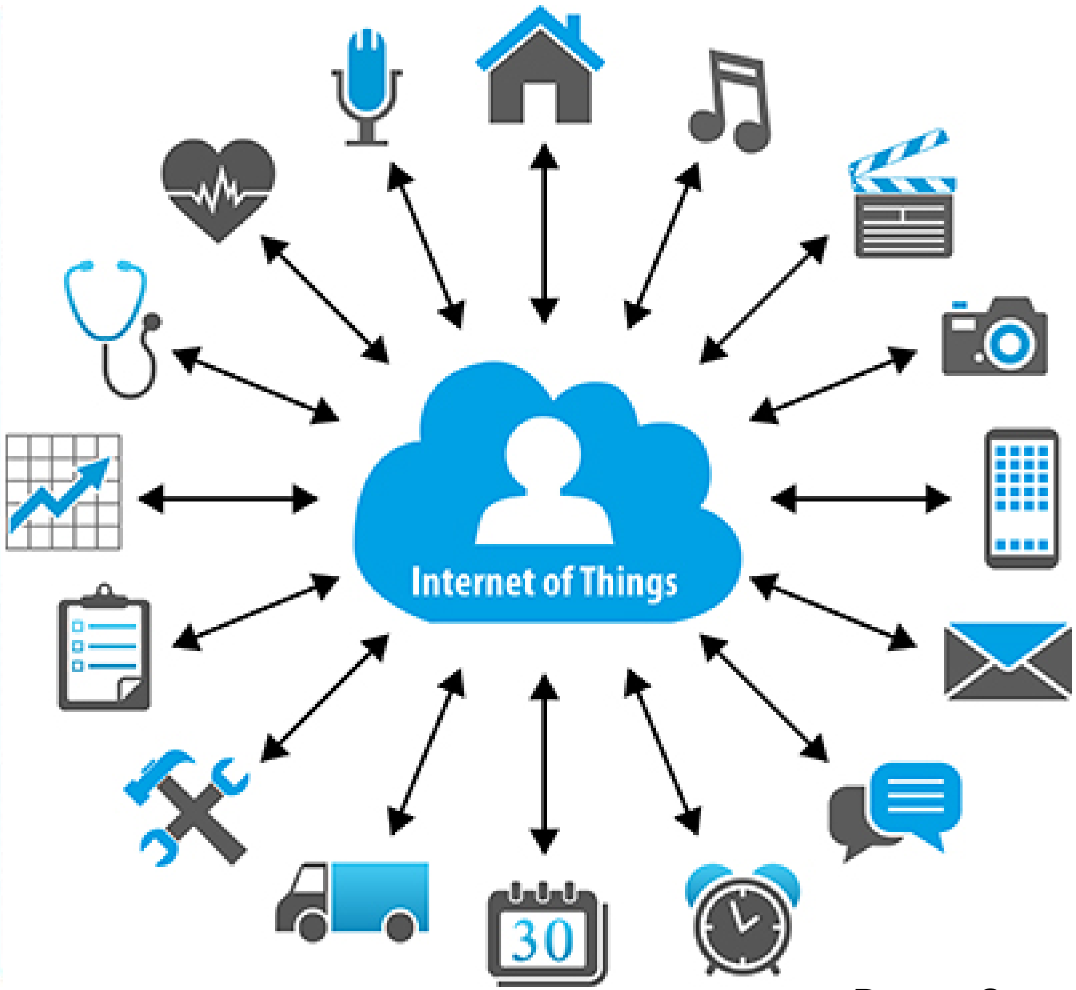
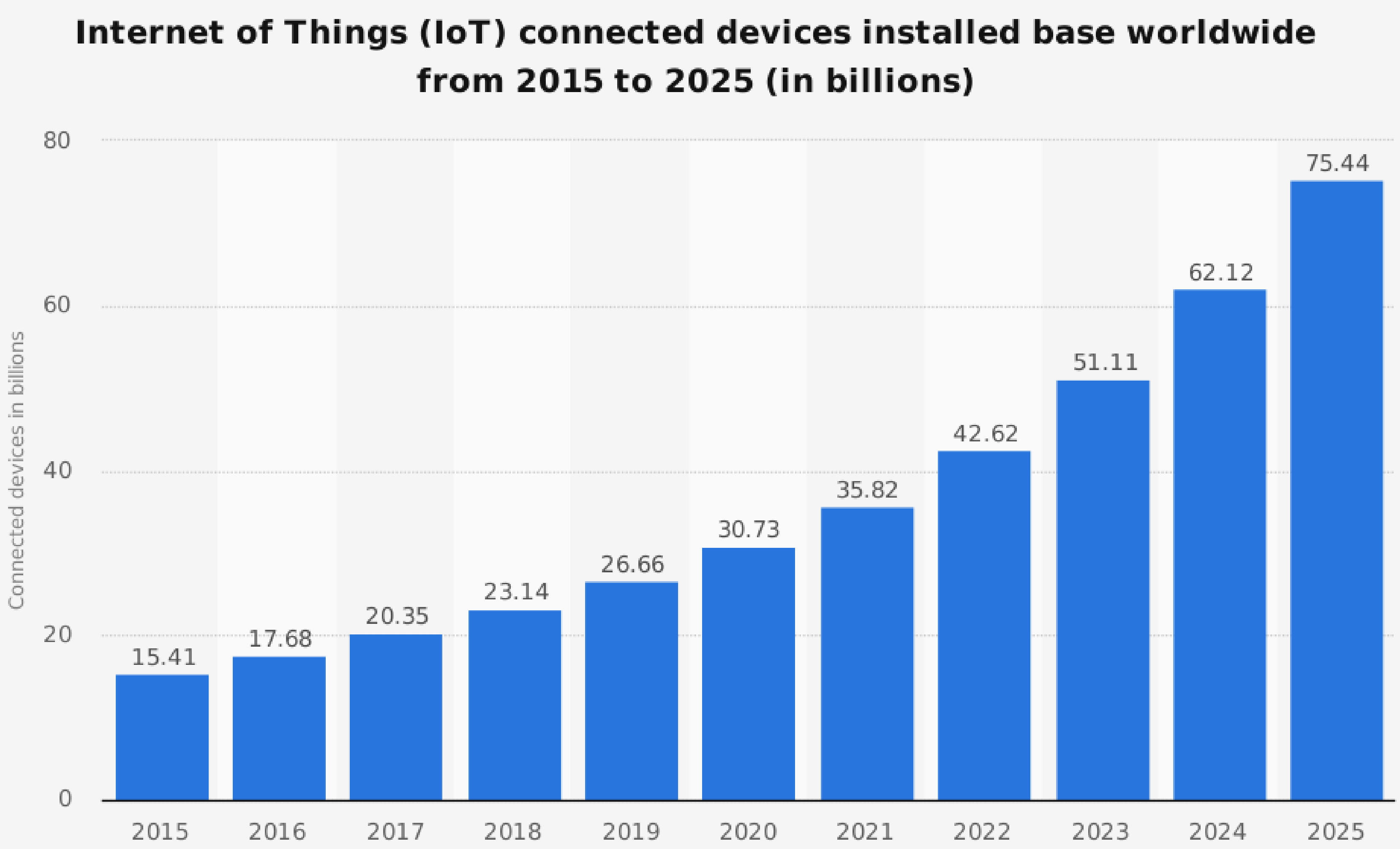
Internet of Things(IoT)







Source:
IHS

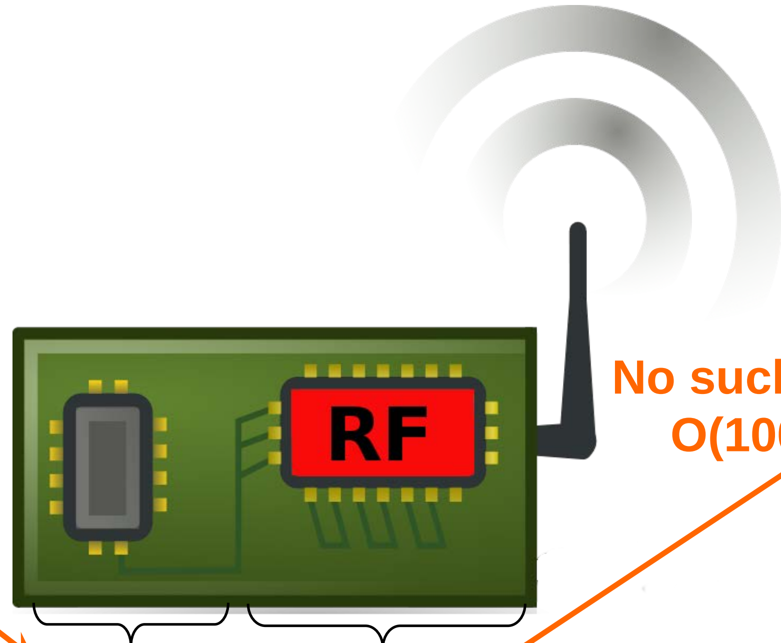
Additional Information:
Worldwide; IHS; 2015 to 2016

Wi-Fi Alliance: surpass 15 billion by end of 2016

Wi-Fi is power hungry

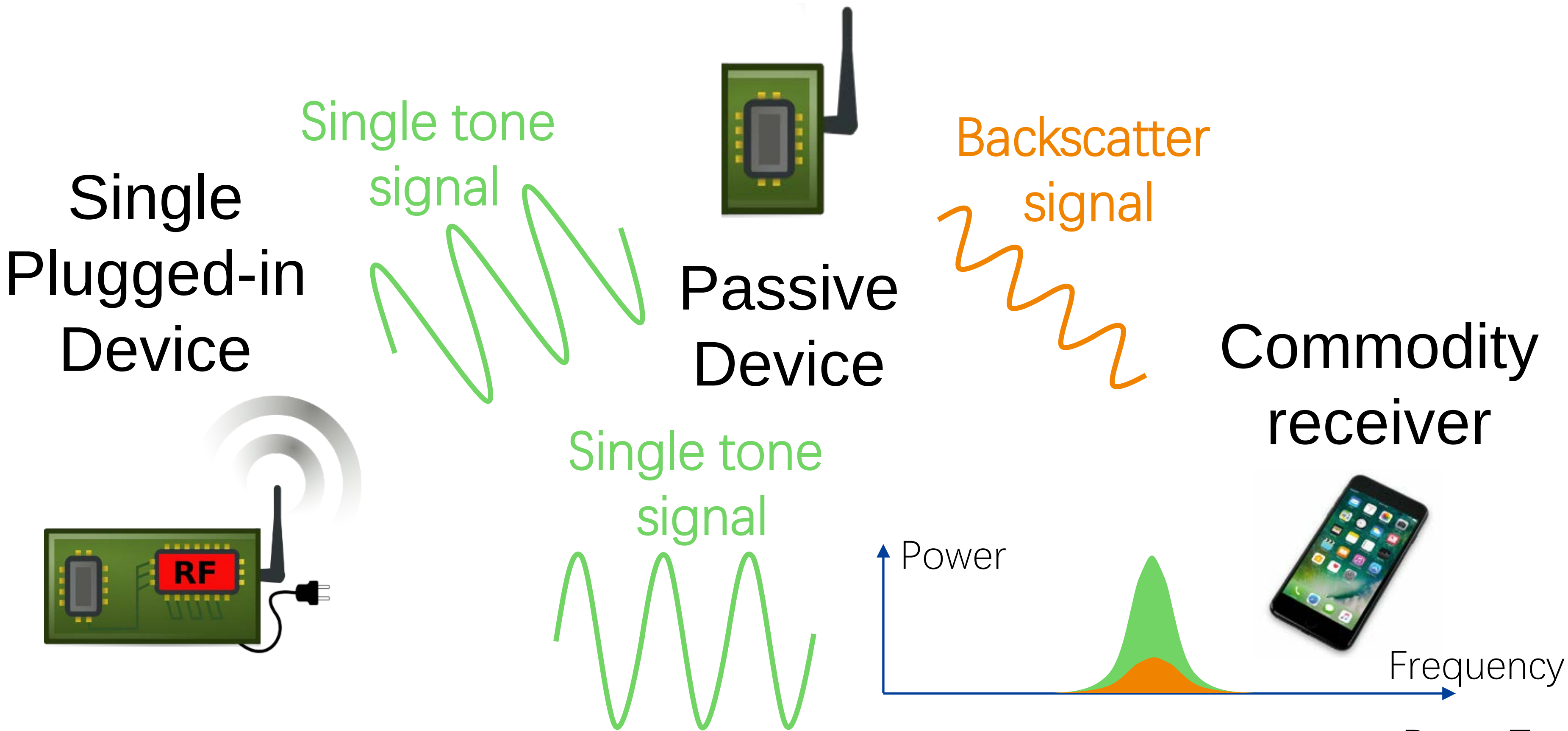
2 or 3 hours

Why is Wi-Fi Power Consuming?

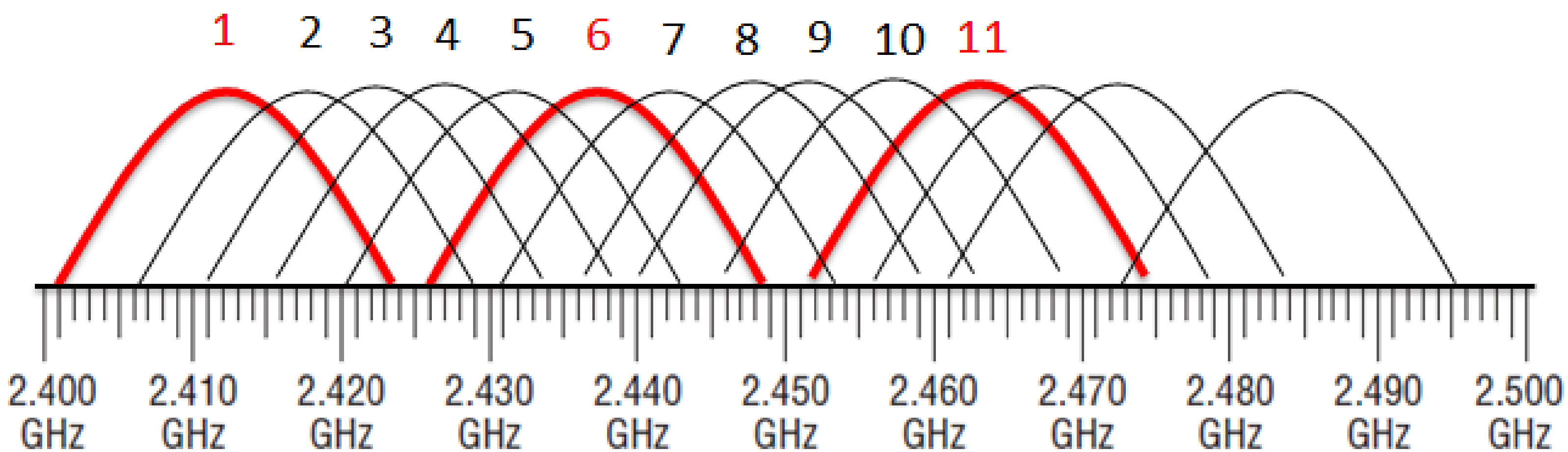


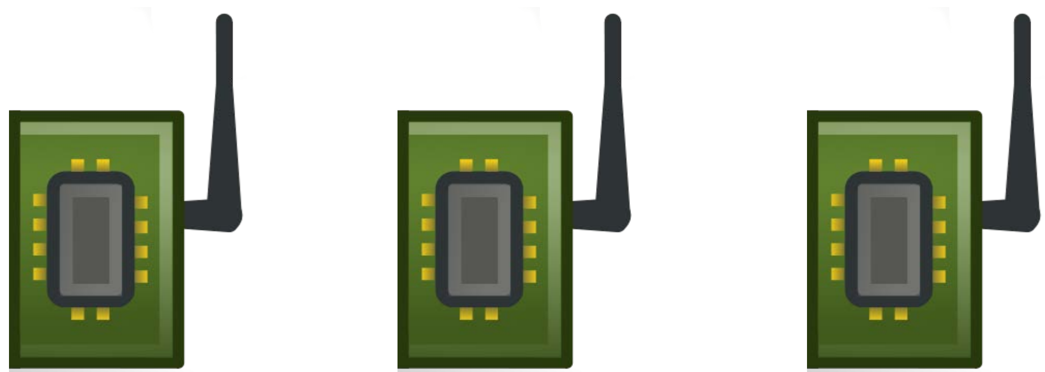
Passive Wi-Fi

Idea: Use only digital baseband



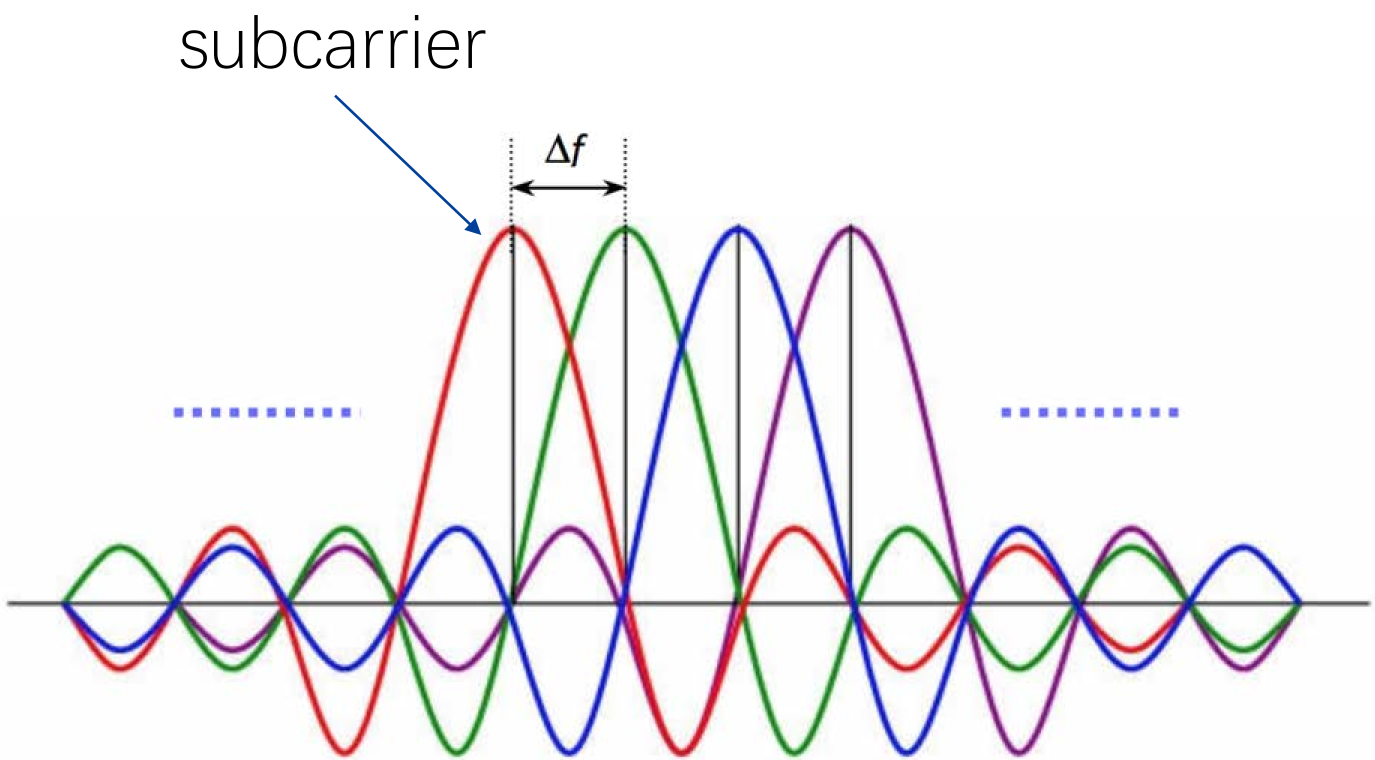
802.11b


1
2
3
4
5
6
7
8
9
10
11
2.400 GHz
2.410 GHz
2.420 GHz
2.430 GHz
2.440 GHz
2.450 GHz
2.460 GHz
2.470 GHz
2.480 GHz
2.490 GHz
2.500 GHz



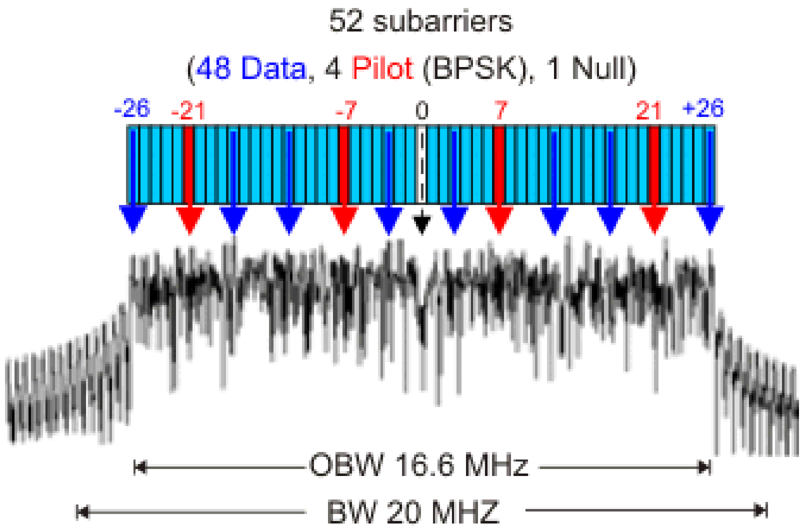
OFDM IS POPULAR SCHEME

OFDM SPECTRUM



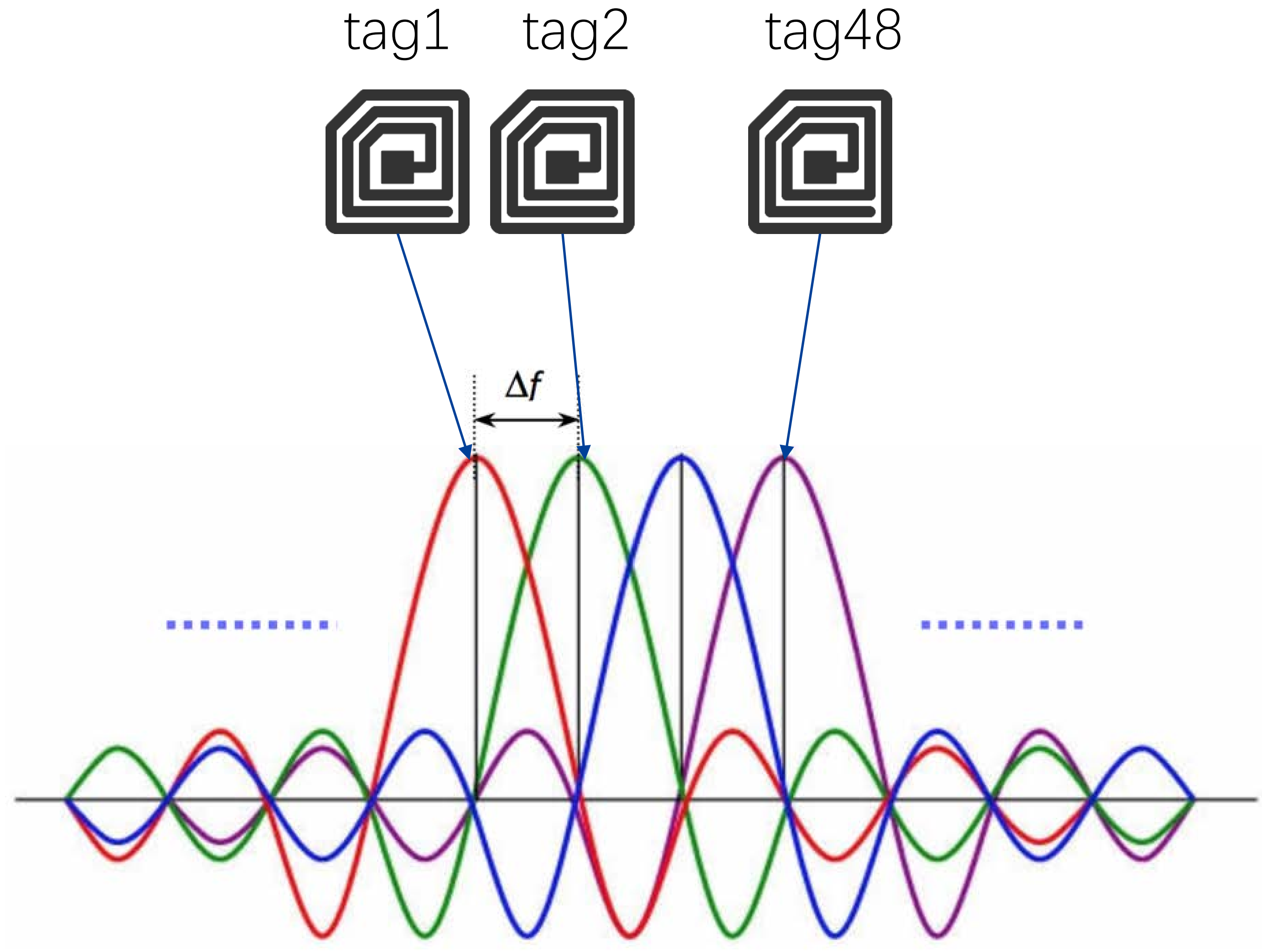
802.11g PHYSICAL PARAMETTERS

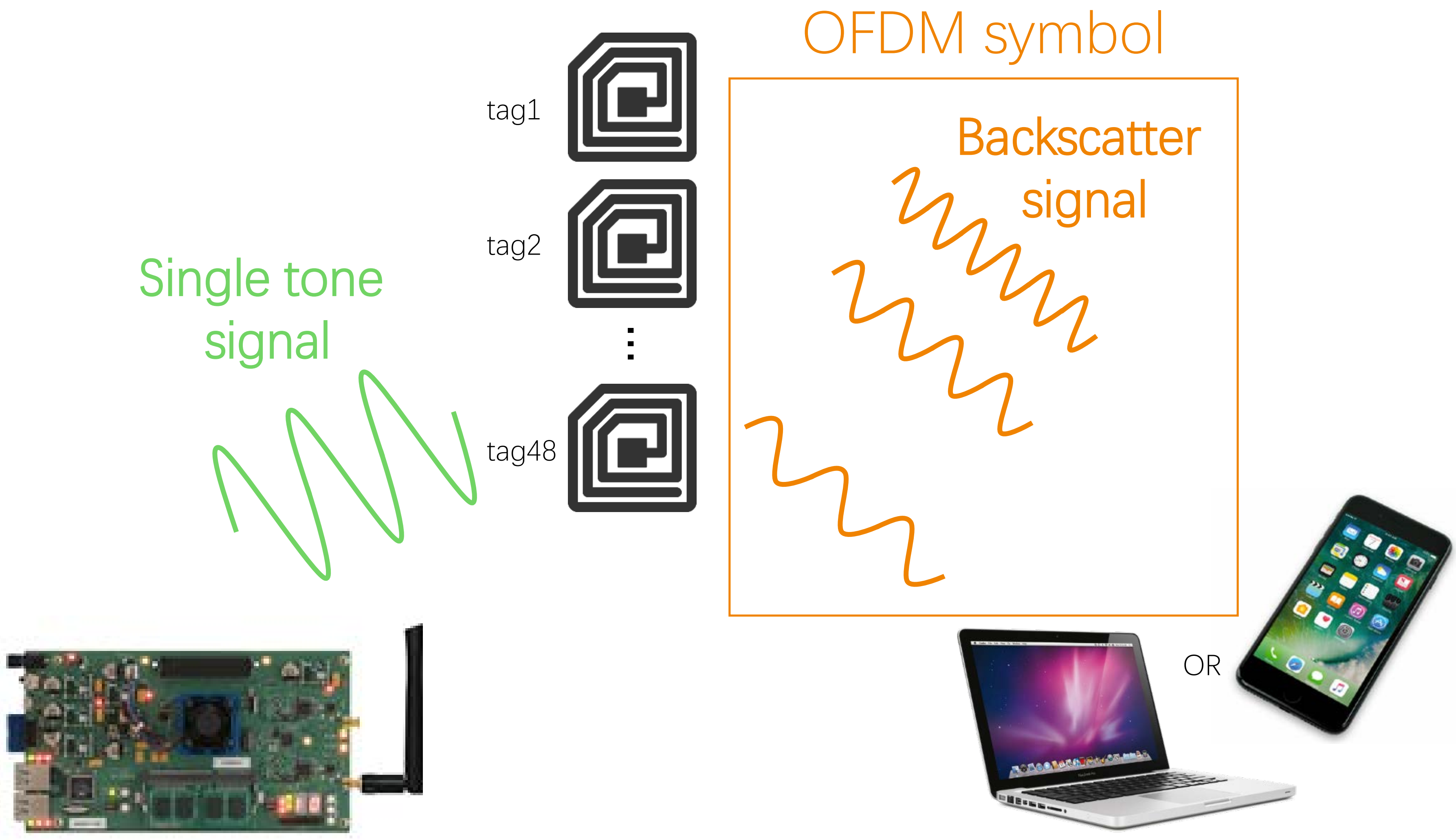
802.11g OFDM PHY Parameters	
BW	20 MHZ
OBW	16.6 MHZ
Subcarrer Spacing	312.5 Khz (20MHz/64 Pt FFT)
Information Rate	**6**/9/**12**/18/**24**/36/48/54 Mbits/s
Modulation	BPSK, QPSK, 16QAM, 64QAM
Coding Rate	1/2, 2/3, 3/4
Total Subcarriers	52 (Freq Index -26 to +26)
Data Subcarriers	48
Pilot Subcarriers*	4 (-21, -7, +7, +21) *Always BPSK
DC Subcarrier	Null (0 subcarrier)



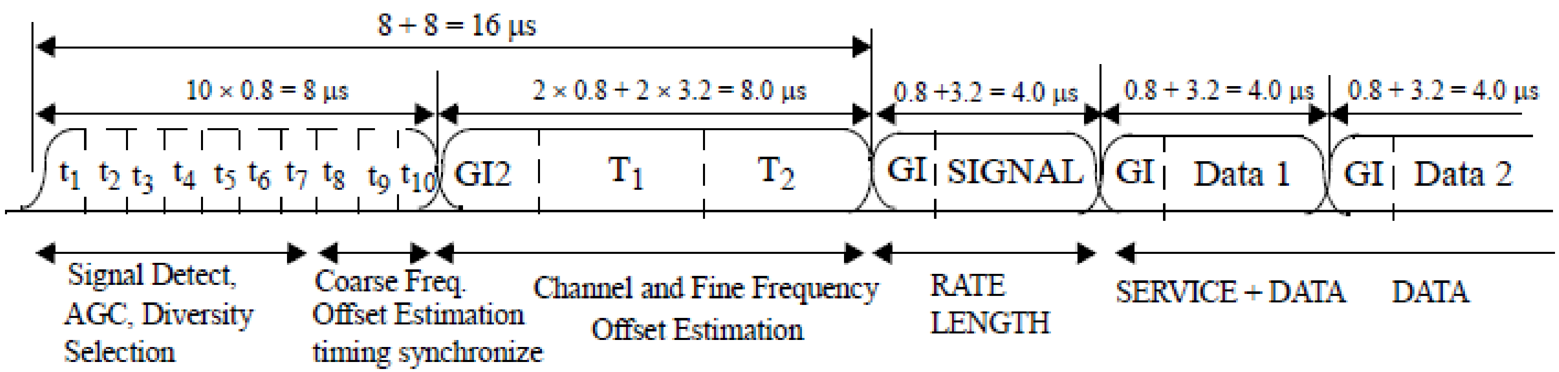
One Subcarrier = 1 constellation point
1 OFDM symbol = 52 subcarriers
1 OFDM Burst = one or more OFDM symbols

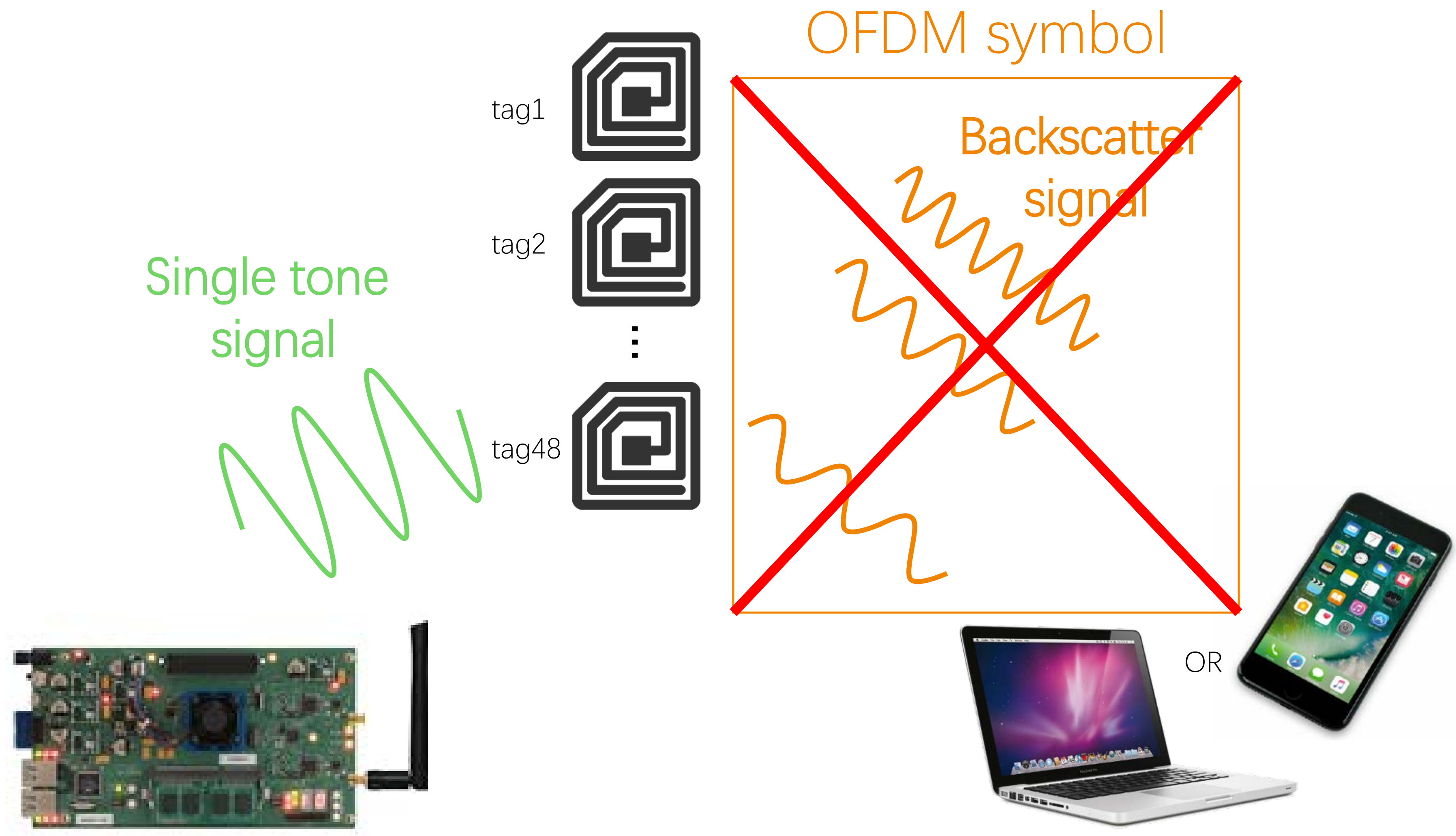
802.11g OFDM Physical Parameters

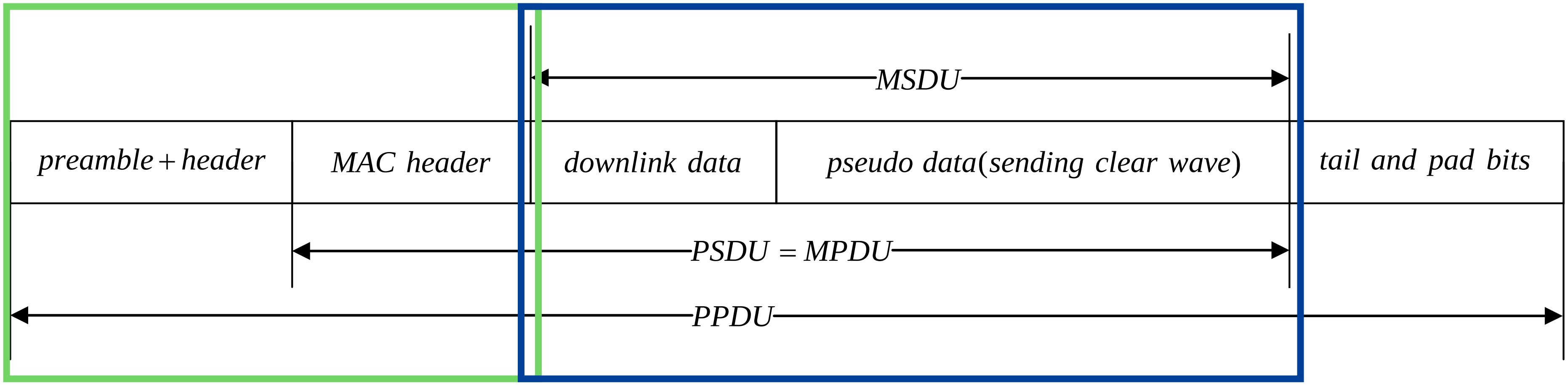

tag1
tag2
tag48
Δf


OFDM symbol
tag1
tag2
tag48
Backscatter signal
Single tone signal
OR


OR

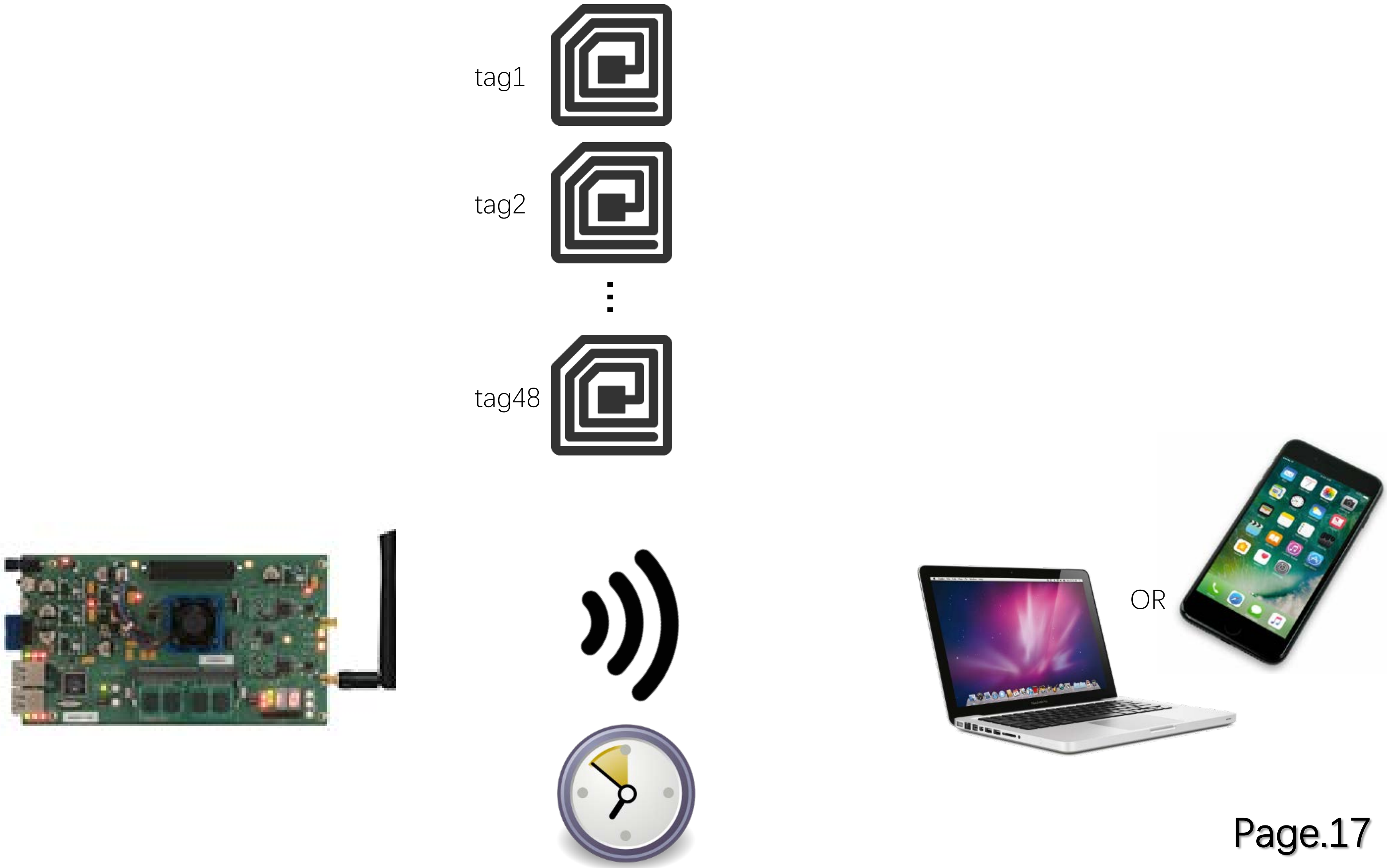

8 + 8 = 16 μs
10 × 0.8 = 8 μs
2 × 0.8 + 2 × 3.2 = 8.0 μs
0.8 +3.2 = 4.0 μs
0.8 + 3.2 = 4.0 μs
0.8 + 3.2 = 4.0 μs
t1 t2 t3 t4 t5 t6 t7 t8 t9 t10
GI2
T1
T2
GI
SIGNAL
GI
Data 1
GI
Data 2
Signal Detect, AGC, Diversity Selection
Coarse Freq. Offset Estimation timing synchronize
Channel and Fine Frequency Offset Estimation
RATE LENGTH
SERVICE + DATA
DATA

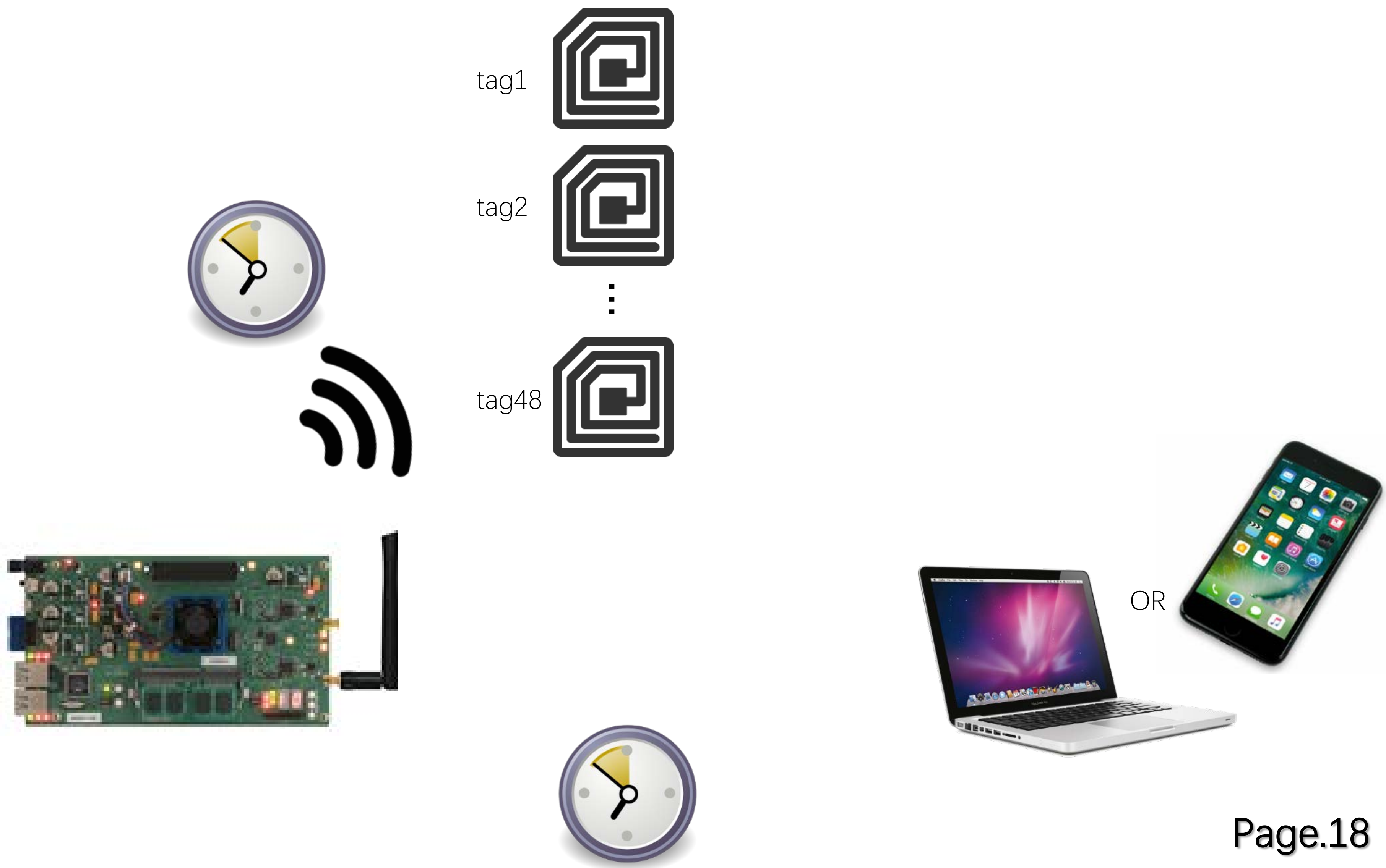

OFDM symbol
tag1
tag2
tag48
Backscatter signal
Single tone signal
OR

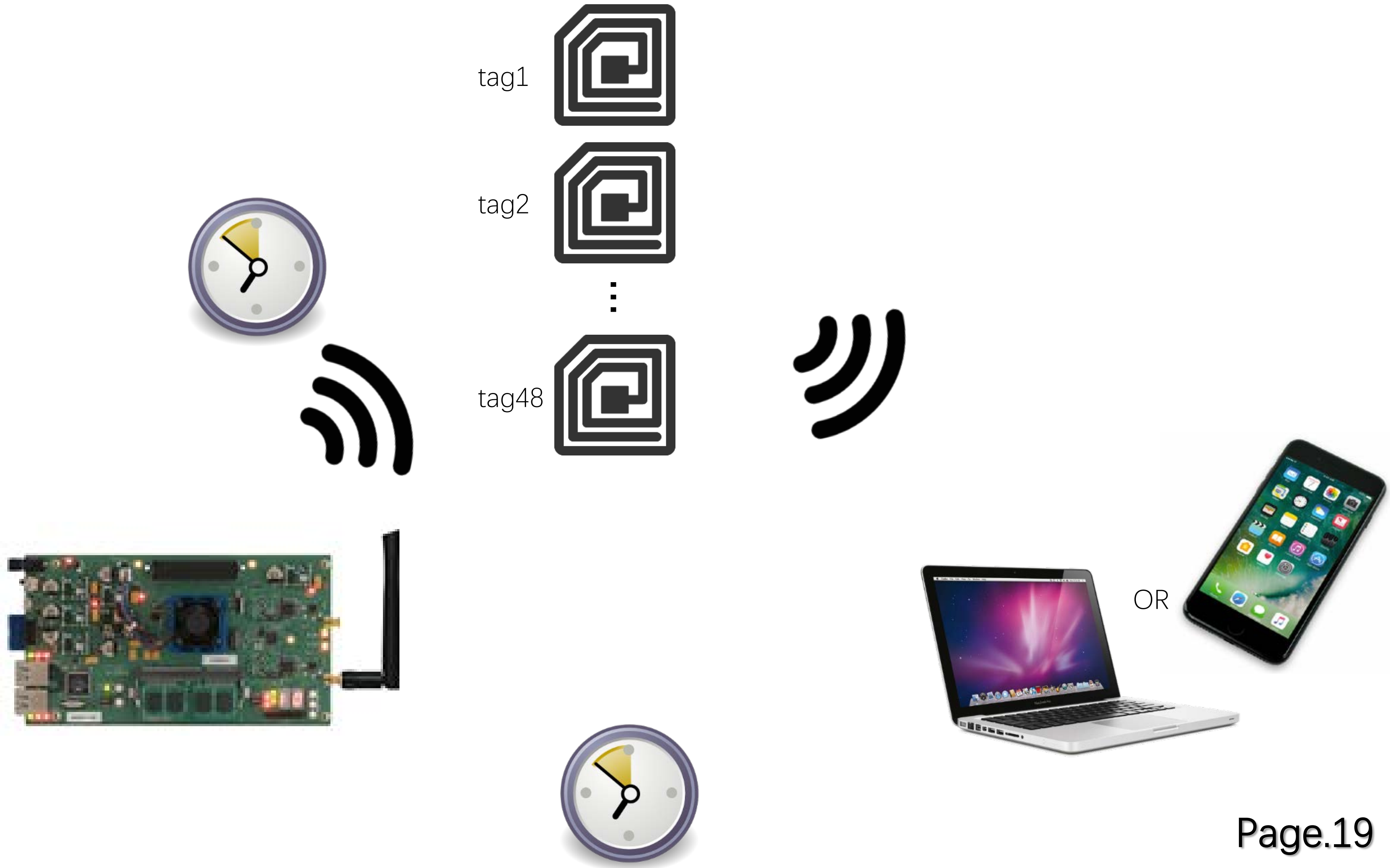


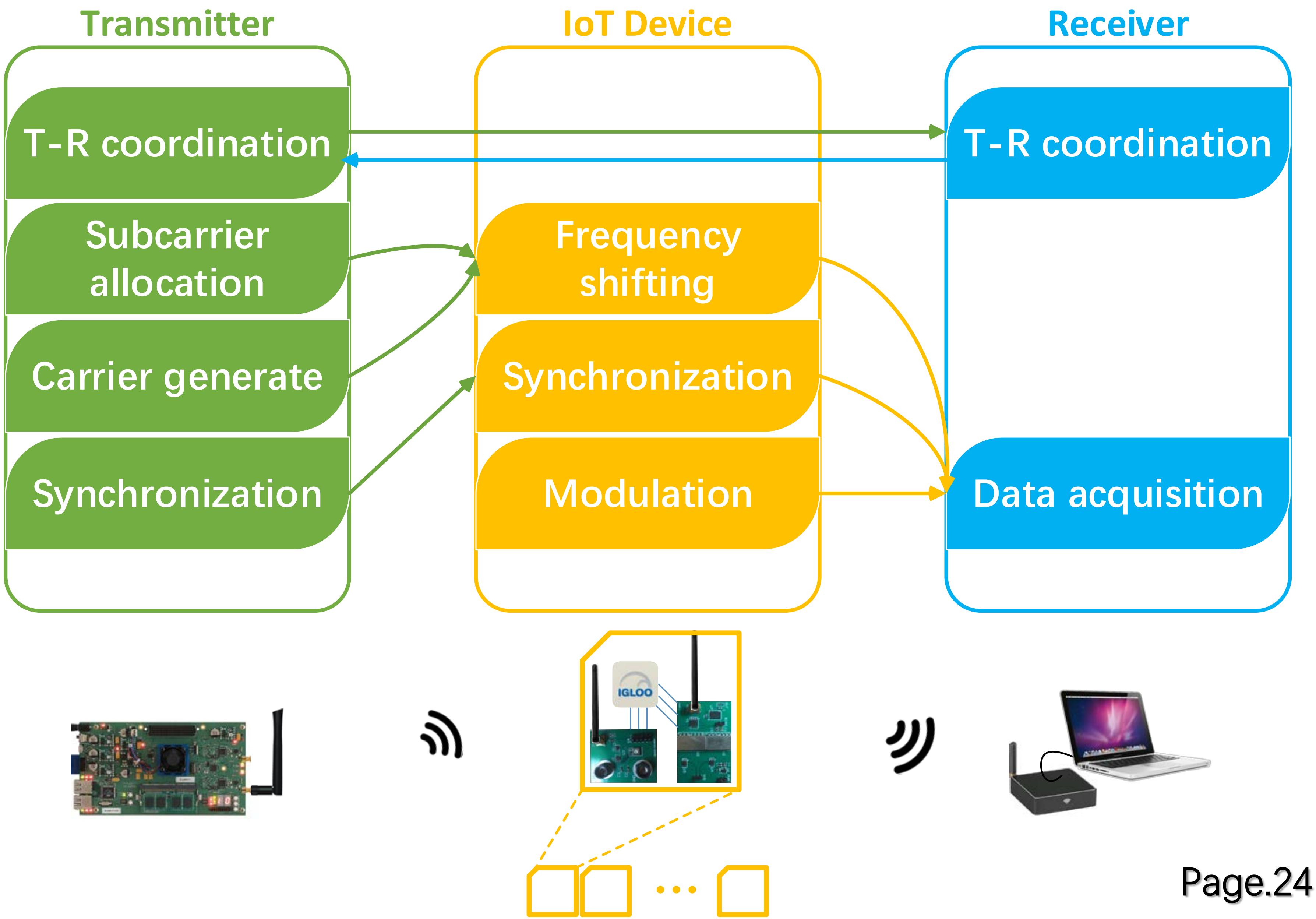
Set up link

For backscatter


tag1
tag2
tag48
OR


tag1
tag2
tag48
OR


tag1
tag2
tag48
OR


Transmitter
IoT Device
Receiver
T-R coordination
T-R coordination
Subcarrier allocation
Frequency shifting
Carrier generate
Synchronization
Synchronization
Modulation
Data acquisition
IGLOO

MORE CAPACITY

- OFDMA system
- CSMA/CA

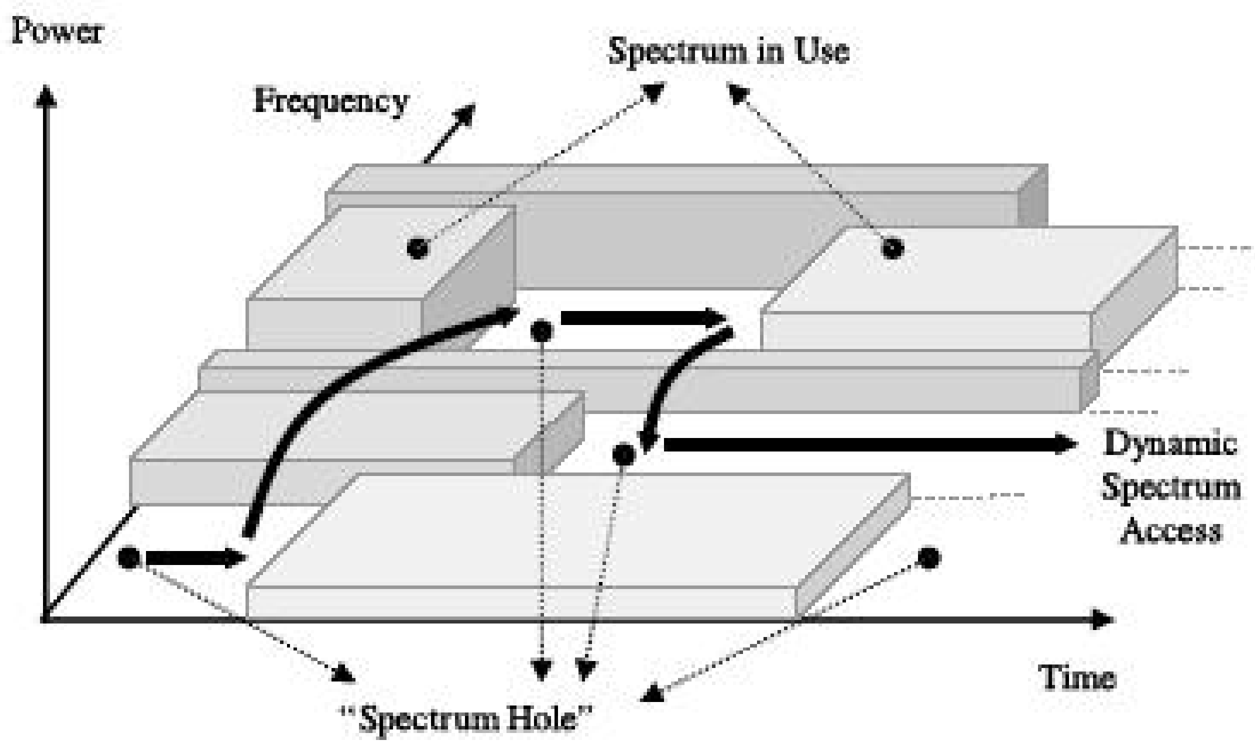
CSMA/CA

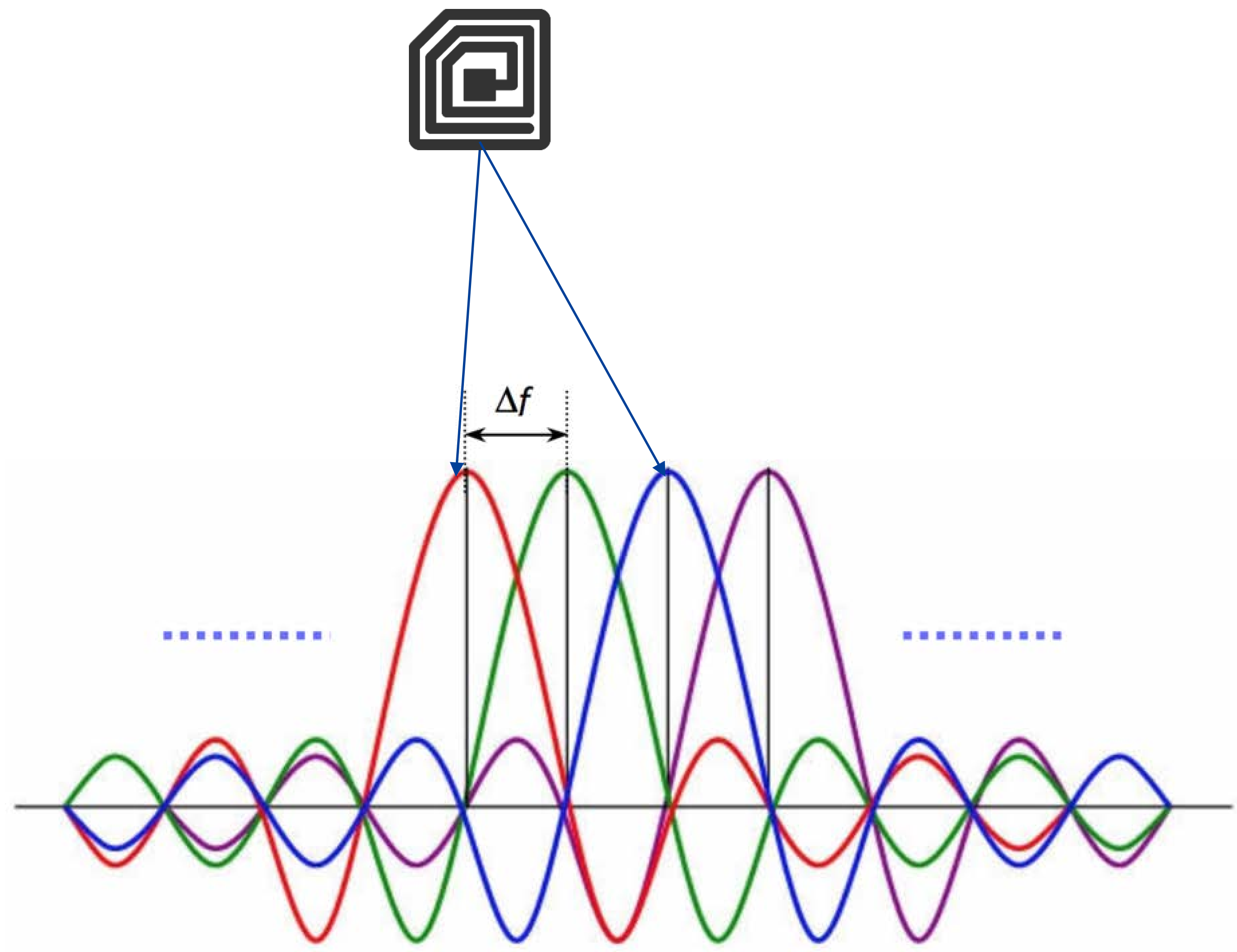
- Packet mode method of multiple access method using in Wi-Fi.
- Coexistence with other ISM devices.
- Medium sensing is power hungry → transmitter

MORE CAPACITY

- OFDMA system
- CSMA/CA
- Cognitive radio

Cognitive radio



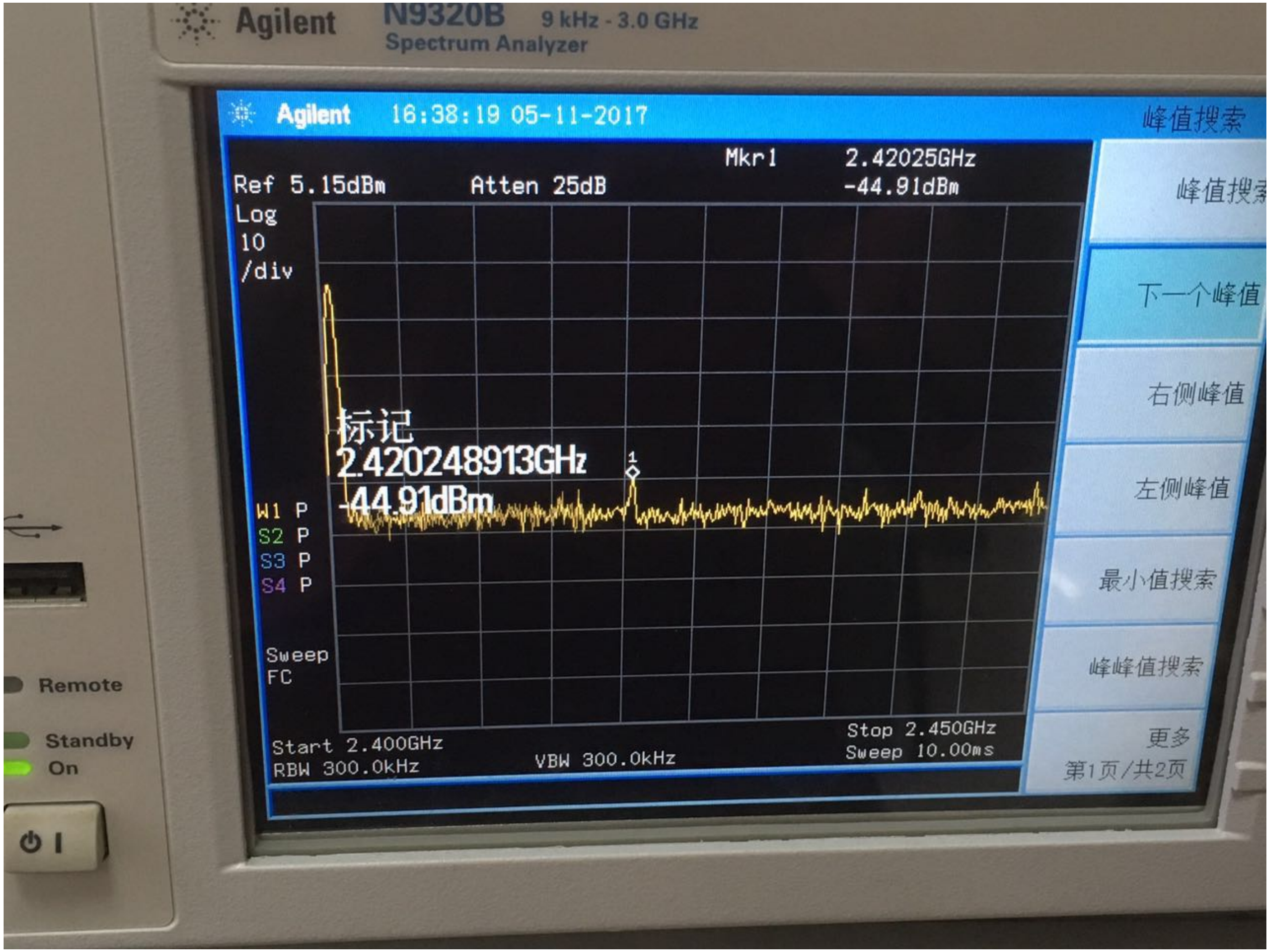

Δf

Cognitive radio

- Flexible clock → PLL
- Also sensing medium (allocation) → transmitter

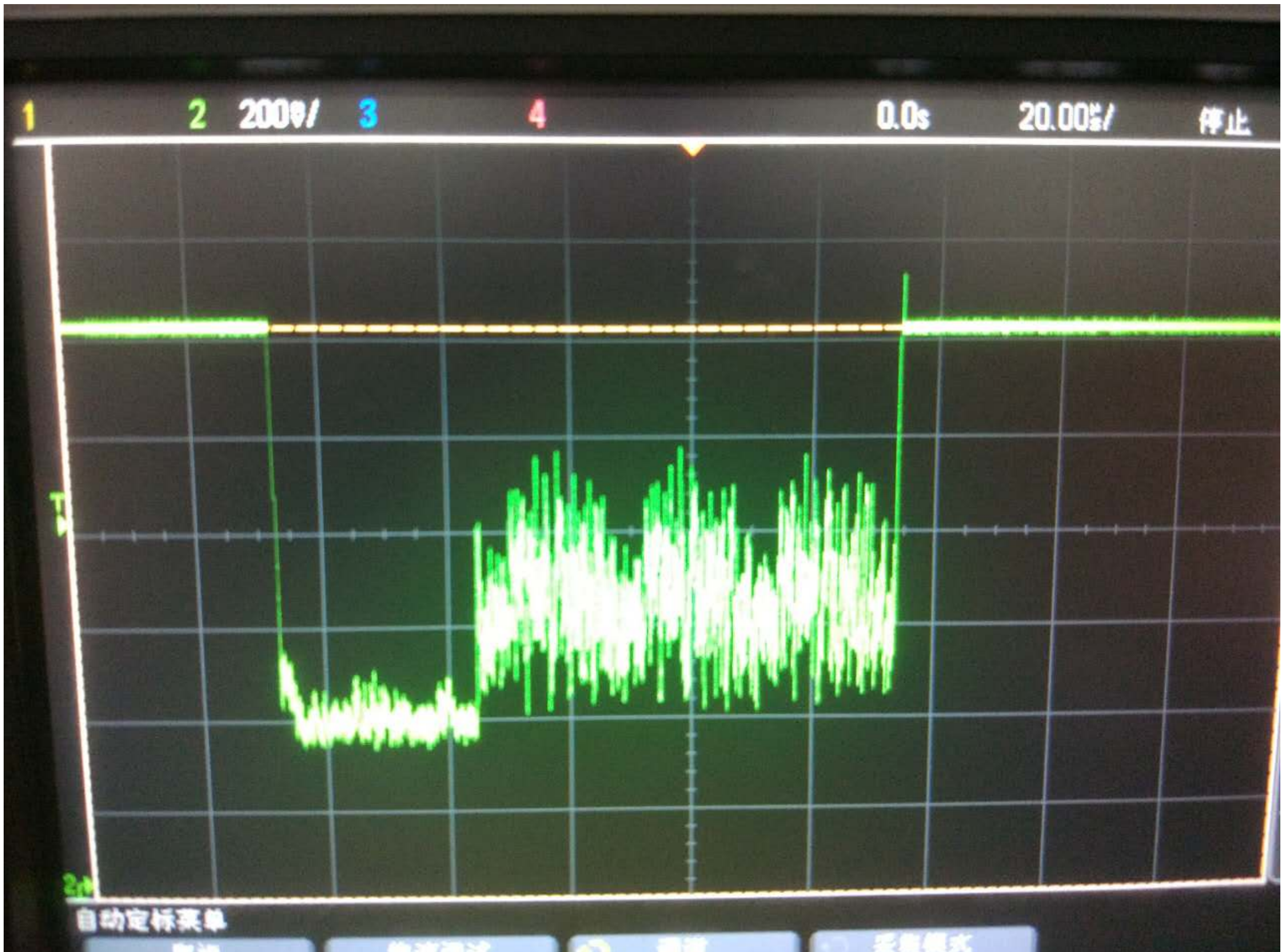
Flash and antifuse technologies
low power PLL 5uW

EVALUATION



Agilent
N9320B
9 kHz - 3.0 GHz
Spectrum Analyzer
Agilent 16:38:19 05-11-2017
峰值搜索
Mkr1 2.42025GHz
Ref 5.15dBm Atten 25dB -44.91dBm
Log
10
/div
标记
2.420248913GHz
-44.91dBm
W1 P
S2 P
S3 P
S4 P
Sweep
FC
Start 2.400GHz
RBW 300.0kHz
VBW 300.0kHz
Stop 2.450GHz
Sweep 10.00ms
下一个峰值
右侧峰值
左侧峰值
最小值搜索
峰峰值搜索
更多
第1页/共2页
Remote
Standby
On

EVALUATION



FUTURE WORK

- Joint debugging → communication performance
- IC design→ power consumption
- REAL OFDM backscatter

OUR CONTRIBUTION

- 1.Introduce the first OFDMA backscatter system.
- 2.Conbine several techniques for low frequency band occupation.
  - Frequency shifting backscatter; single side band; bi-directional communication.
- 3.Design a network stack frame to implement.
  - Cognitive radio; CSMA/CA.
- 4.Build a prototype based on commodity devices.

COMPARISON

System	Passive Wi-Fi[1]	FS-Backscatter[2]	HitchHike[3]	Inter-Backscatter[4]	Our system
Throughput (Kbps)	1000/11000	50	200/300	2000	100/250
Range (m)	30	3.6	54/34	27	20
Power consumption (μW)	14.5/59.2	45	33	28	~ 30
Capacity (/channel)	1	1	1	1	48
Band occupation	1+1*	2	2	1+1*	1
Mirror signal	Y	Y	N	N	N
Commodity device	N	Y	Y	Y	Y

*1+1 means besides the channel frequency band occupied by the data signal the system also occupies another frequency band for the original signal.

Q&A

THANKS！