IoT and Wearables

Secure Mobile IoT Application Development

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University of Nebraska at Omaha
Secure Mobile IoT Development

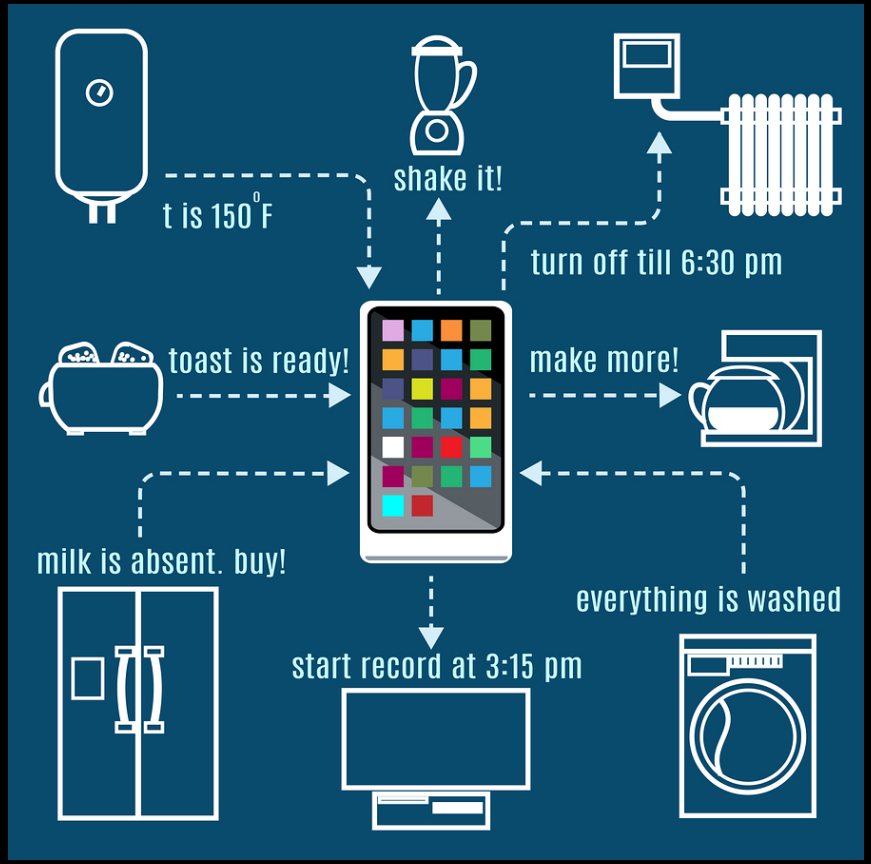
Today's Class: More on Hybrid apps and Lab time

Part 1: IoT Background

- stats and intro
- attack types
- protocol

Part 2: Demo (Demo Gods Permitting)

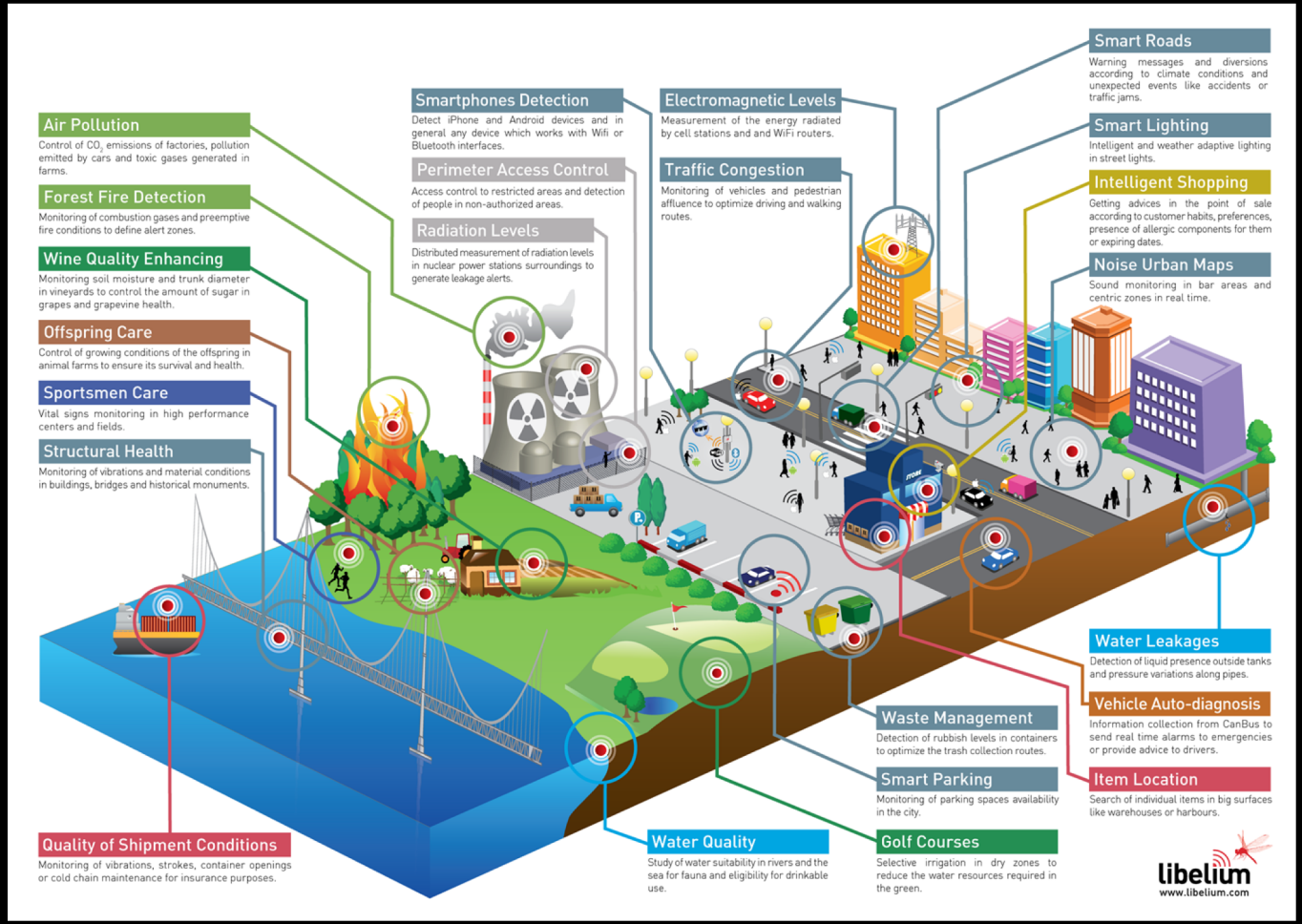
Part 3: Lab time (new IoT lab up)



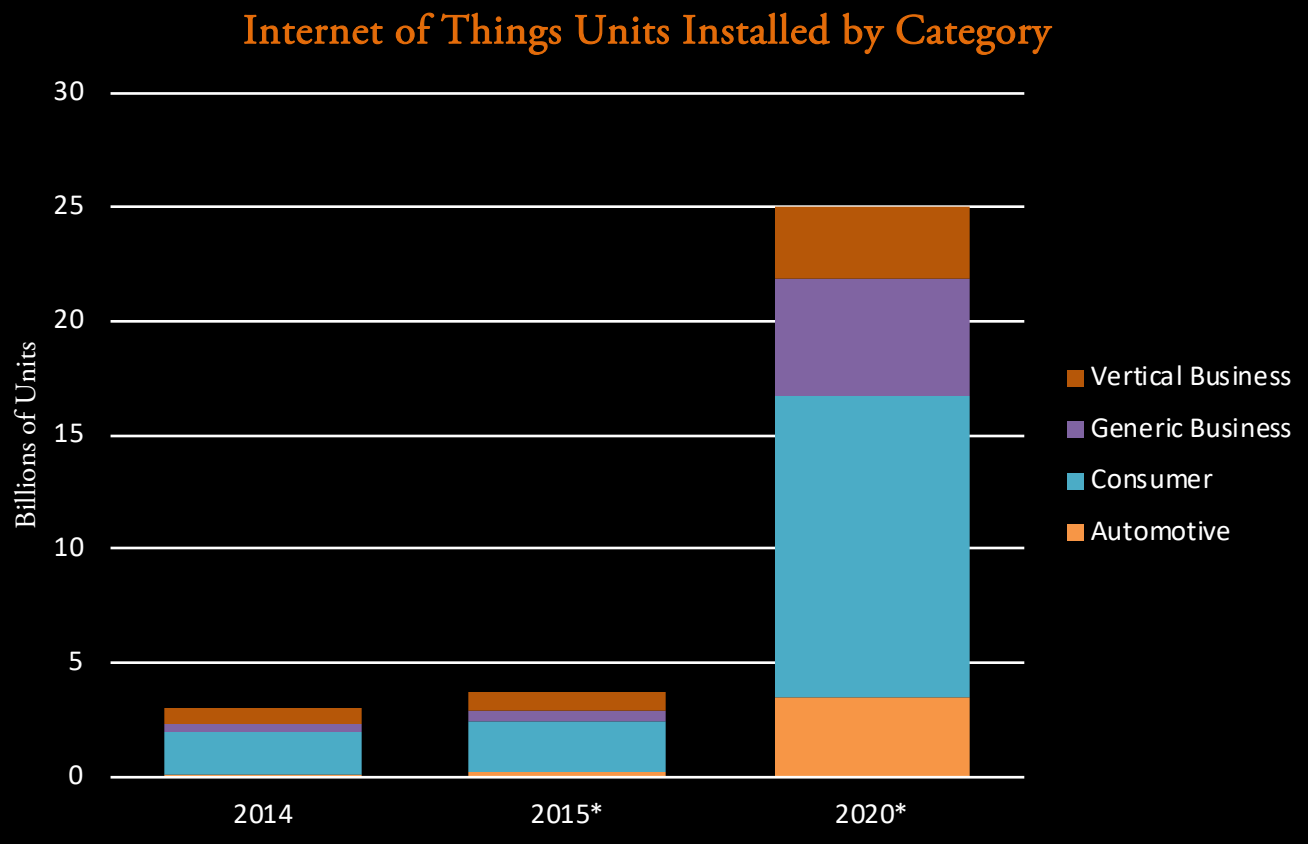
What is the internet of things and why should you care?

What is the internet of things?

Sensors
Embedded
Everywhere



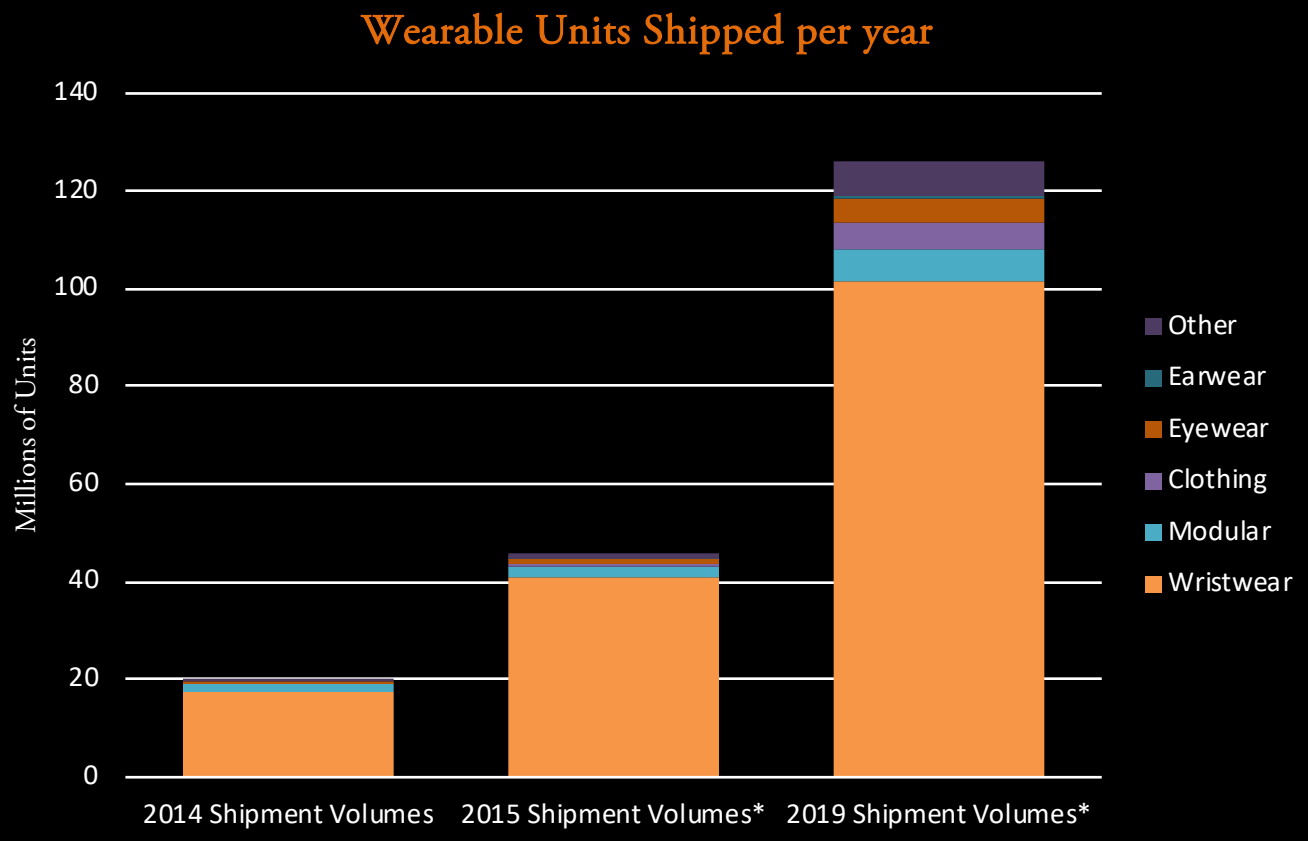
An Idea of Scale (IoT)



* Forecasted figures

Source: Gartner: 4.9 Billion Connected "Things" will be in use by end of 2015, November, 2014

An Idea of Scale (Wearables)



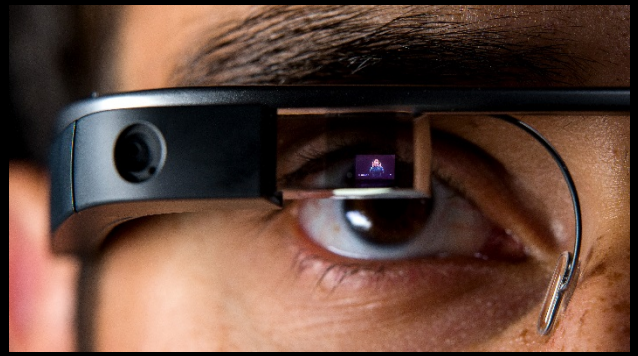
* Forecasted figures

Source: IDC Worldwide Quarterly Wearable Device Tracker, March 30, 2015

133.4% Growth from 2014 to 2015 (19.6M to 45.7M)

45.1% Five-year compound annual growth rate (19.6 to 126.1)

fitbit surge



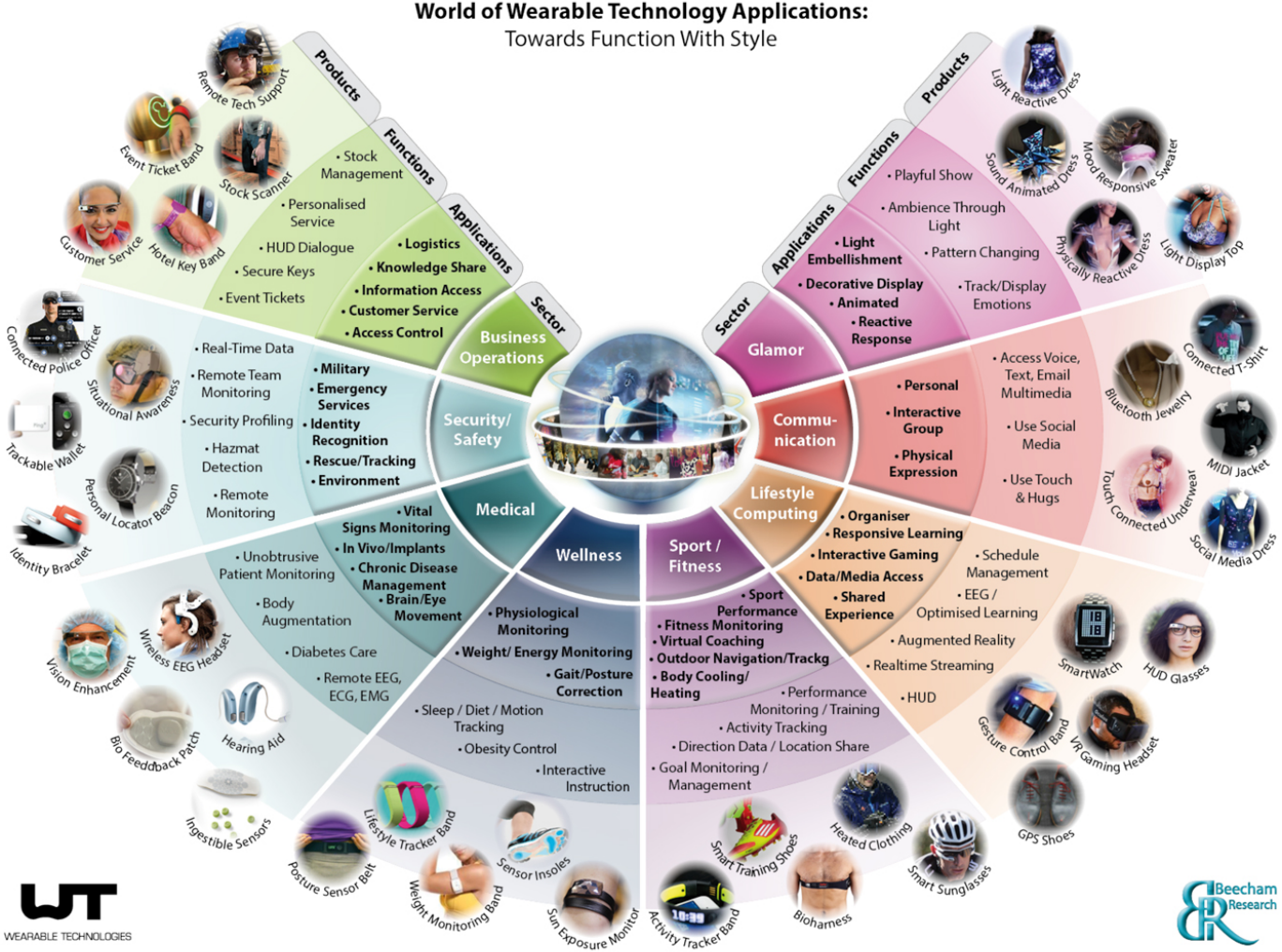
GLASS

…ok so what? its sleep and pedometer data.

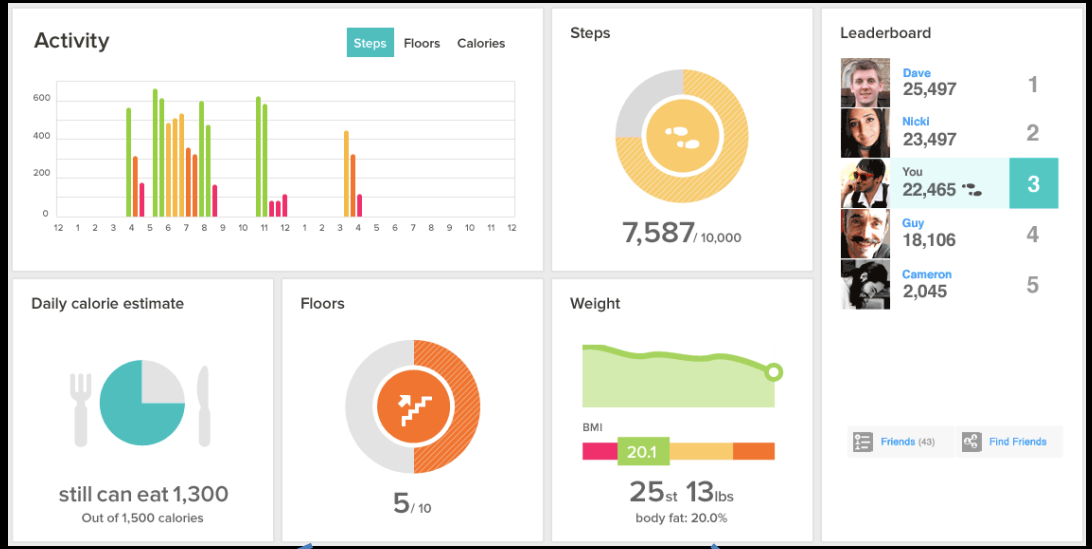
NIKEFUEL

UP
by JAWBONE™

Not exactly.



The possibilities:



Big data is also important for other sectors

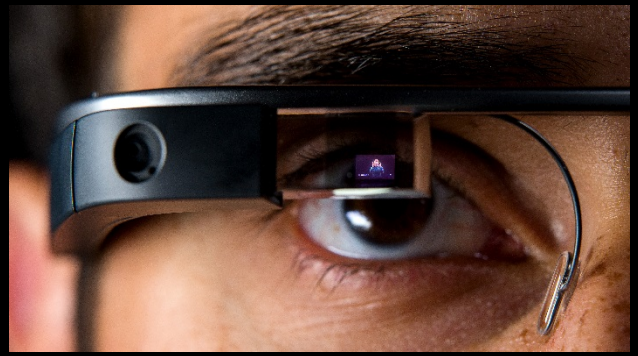
Medical -> patient well being & diagnosis

Military -> warfighter well being / operational intelligence

SITUATIONAL AWARENESS

Yeah it's important

fitbit surge™



GLASS

…there are many security challenges

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(in)security landscape

Domain security issues

User Awareness and Privacy Behaviors	Don't recognize data sensitivity or misuse May install malware or malicious apps Apps may be an invasion of privacy
Web Application	Standard Web attacks (XSS, SQL injection, CSRF, etc) Information Leakage (e.g. geotagging in social media) Secure data storage and acceptable data usage
Mobile Application	Third party tracking apps accessing data (stored/in-transit) Data encoding and transmission Resource consumption
Wearable Hardware	Physical tampering Data encoding and transmission Resource consumption

Inter-domain security issues

User Awareness and Privacy Behaviors

Web Application

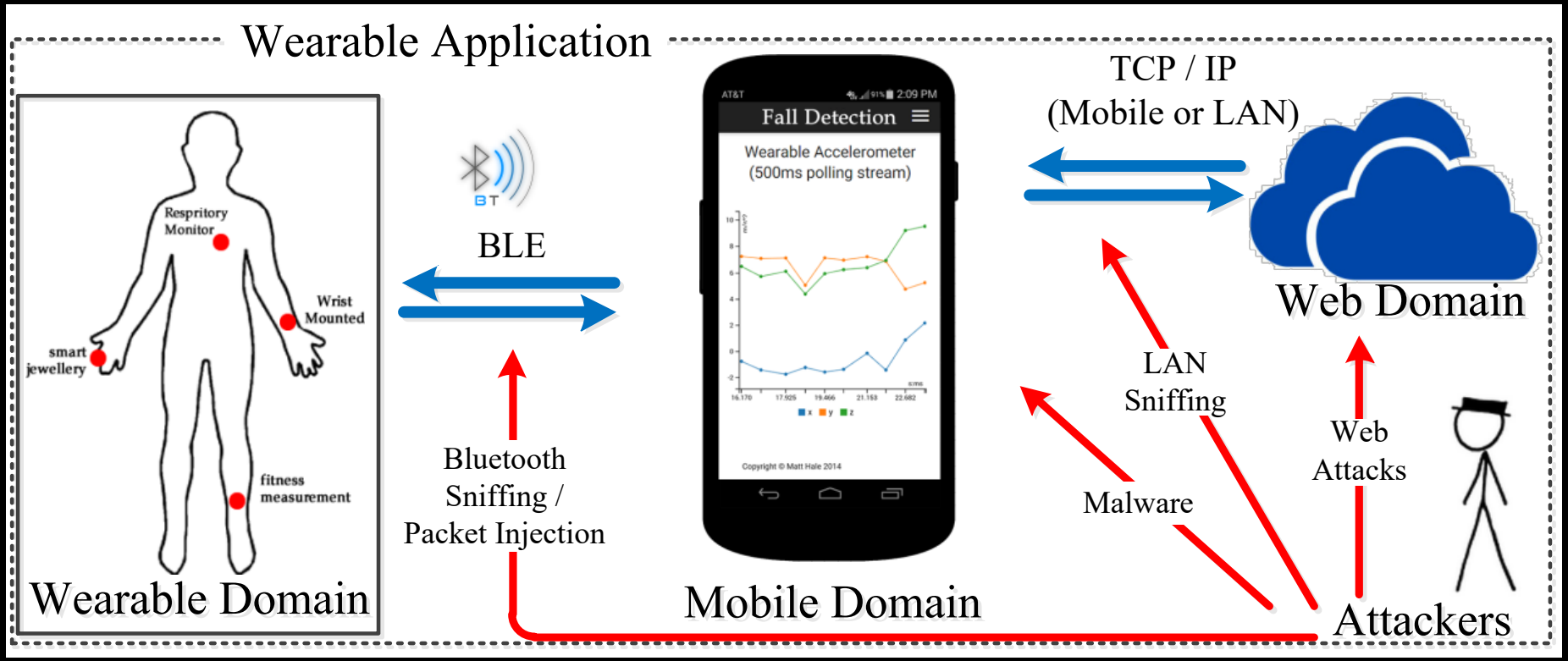
Insecure Wi-Fi or 4G
Lack of API Security (HTTPS/CORS/CSRF)

Mobile Application

Lack of over-the-air encryption
Man-in-the-middle attacks
Denial of service / Resource consumption

Wearable Hardware

Attack vectors for a typical app



Home › Api › Logitems

Select logitem to change

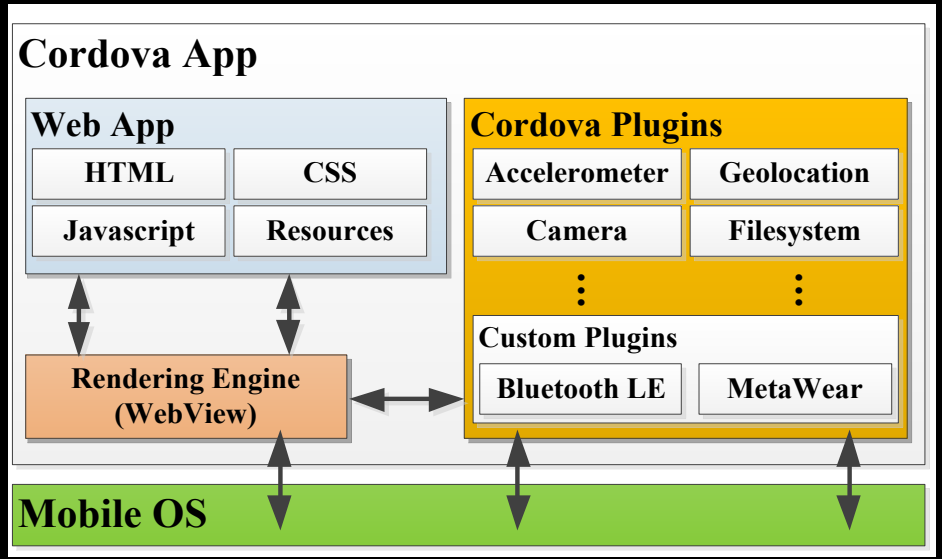
Action: --------- ▼ Go 0 of 100 selected

id	type	data	datetime
3386	9 (LED Event)	{"op": "off", "color": "green","timestamp":1427179.....	March 1, 2015, 6:41 a.m.
3385	10 (Temperature)	{"temp":22.71,"timestamp":1427179691010}	March 1, 2015, 6:40 a.m.
3384	11 (Accelerometer)	{"op": "on-flash", "color": "green","timestamp":14.....	March 1, 2015, 6:39 a.m.
3383	11 (Accelerometer)	{"x":0.21847090125083923,"y":-1.2078747749328613,".....	March 1, 2015, 6:39 a.m.
3382	11 (Accelerometer)	{"x":0.20290859043598175,"y":-1.184531331062317,"z.....	March 1, 2015, 6:39 a.m.
3381	11 (Accelerometer)	{"x":0.11851298063993454,"y":-0.8038532137870789,".....	March 1, 2015, 6:39 a.m.

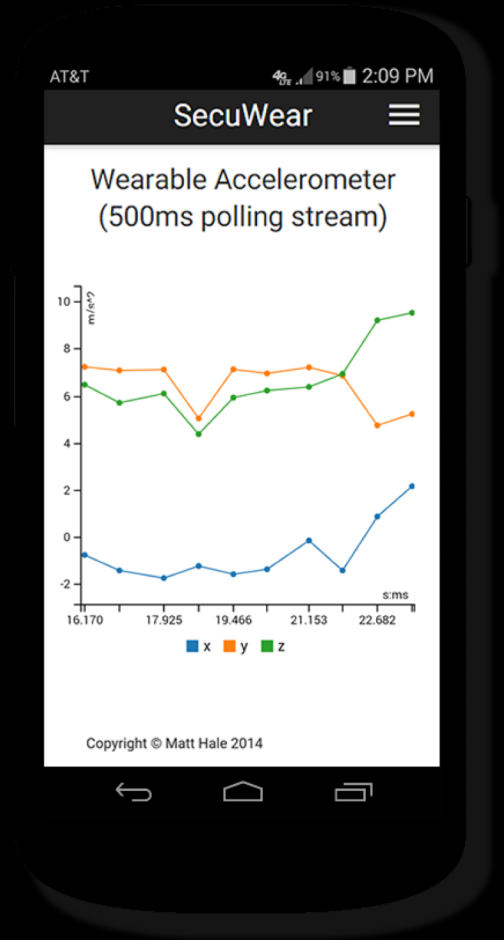
example API*
(Web Domain)

* Similar to what we used in class to store persistent mobile attacks (e.g. XSS)

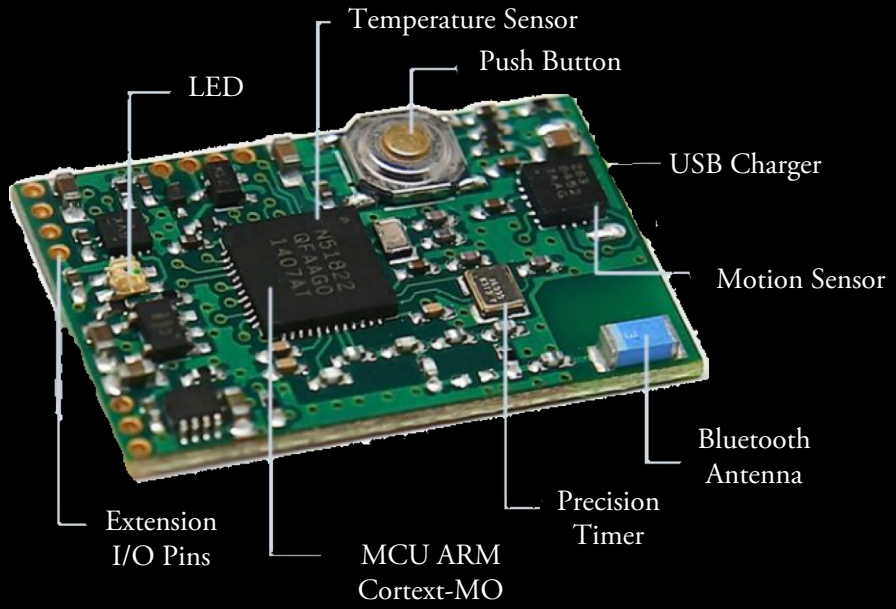
Ex Mobile App
(Mobile Domain)



Ex Mobile App*
(Mobile Domain)



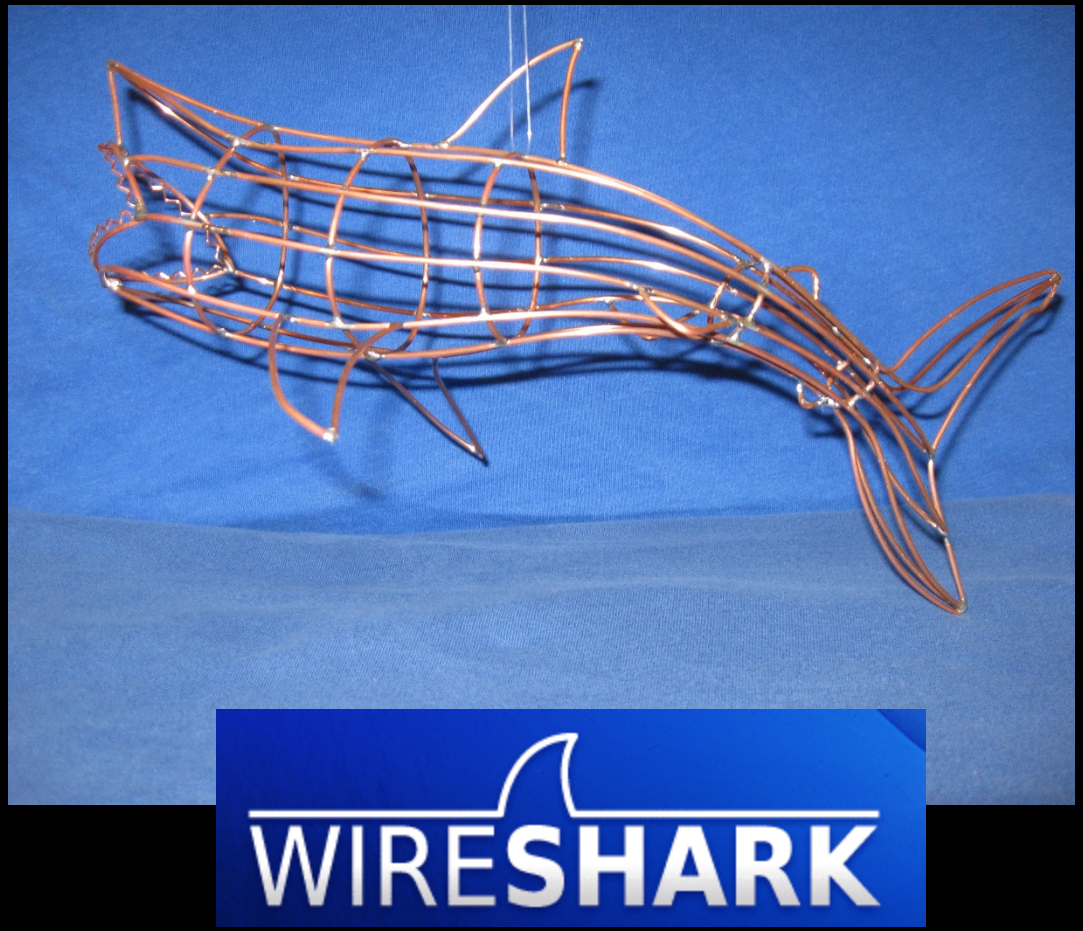
* Other accessible features include temperature sensor, LED, and battery level (based on MetaWear module)



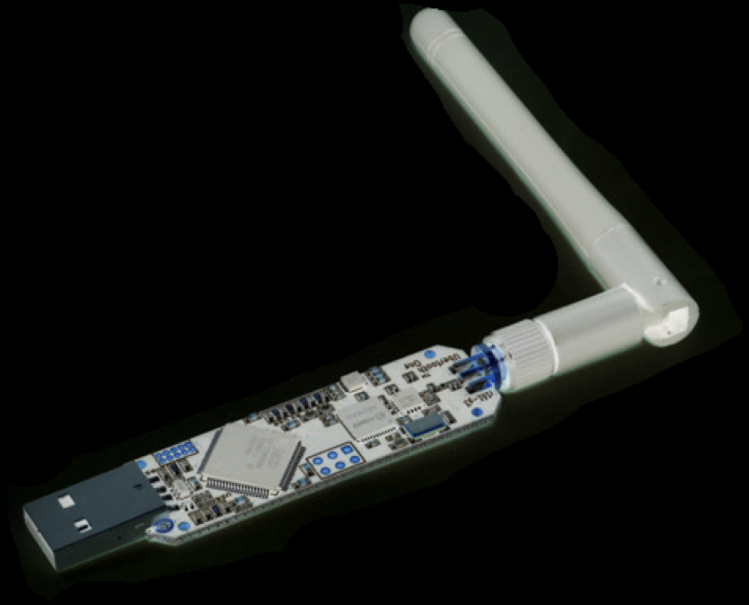
Ex. Wearable – Metawear (Wearable Domain)

mbientlab

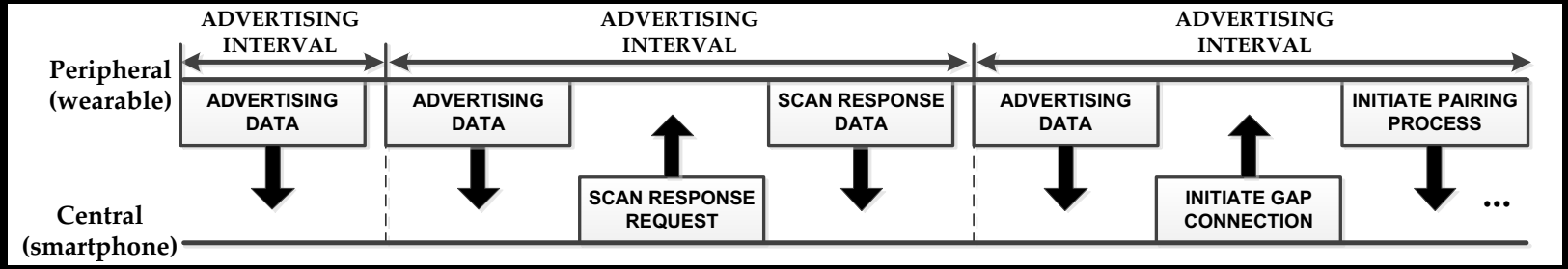
Sniffing Tools
(Inter Domain)



Sniffing Tools
(Inter Domain)

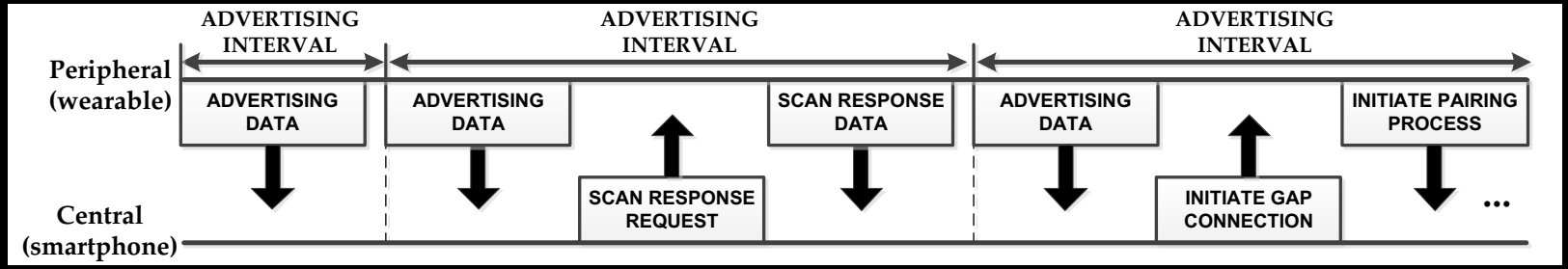


Ubertooth One



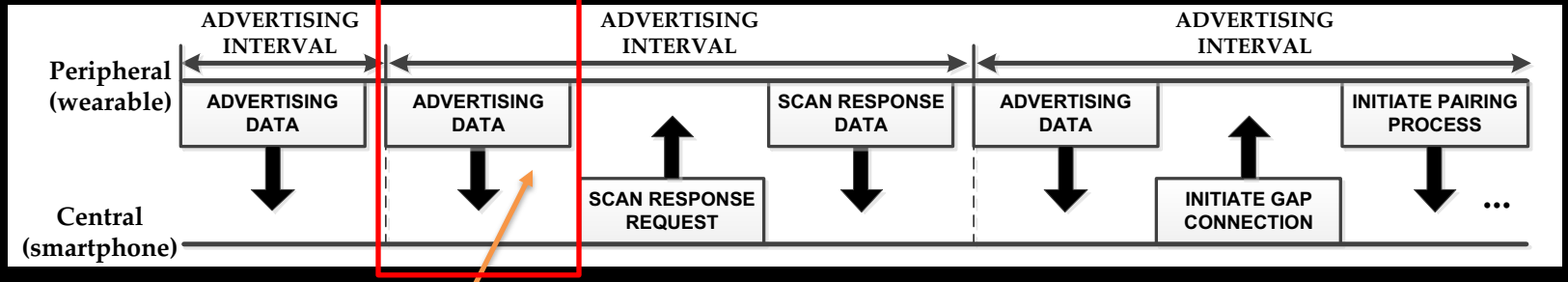
Mainly focused on Bluetooth LE

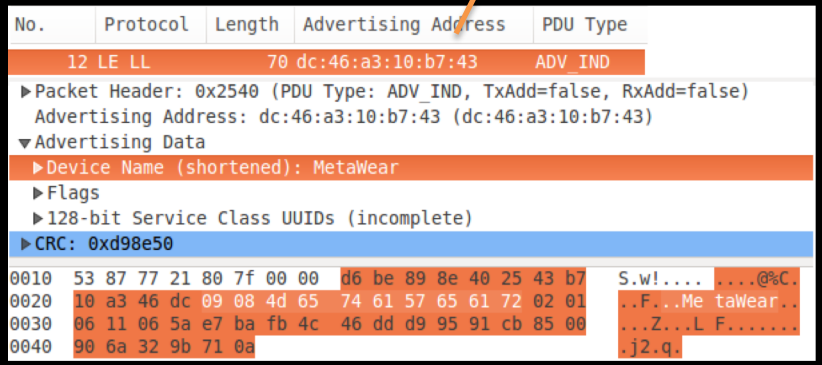
Sniffing Process



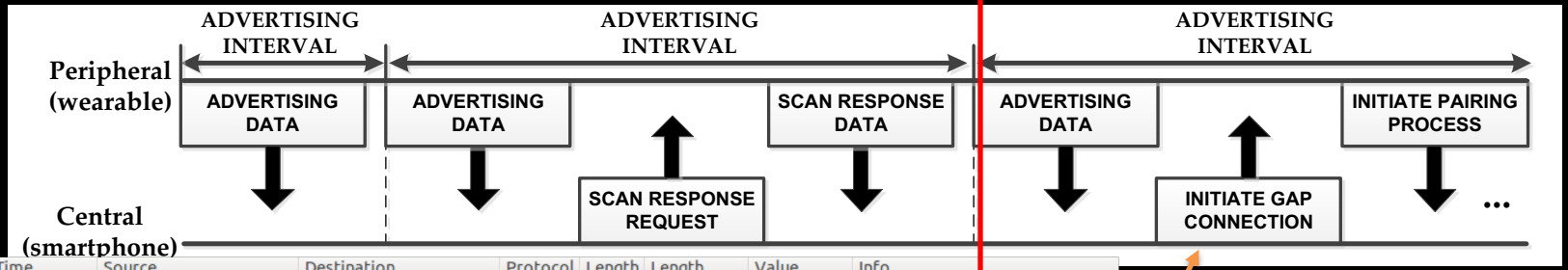
Here is what it looks like…

Sniffing Process





Sniffing Process



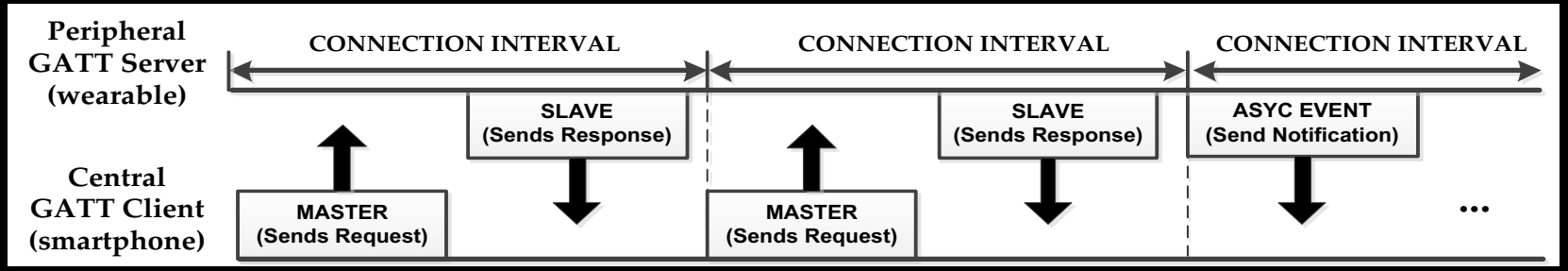
No.	Time	Source	Destination	Protocol	Length	Length	Value	Info
96	6.307693100	11:d3:52:83:2e:57		Bluetoot	62	29		ADV_IND
97	6.676459100	11:d3:52:83:2e:57		Bluetoot	62	29		ADV_IND
98	6.695579800	57:23:d7:fe:b4:d9		Bluetoot	70	37		ADV_IND
99	6.696074300	74:e4:72:c6:ca:4e	57:23:d7:fe:b4:d9	Bluetoot	67	34		CONNECT_REQ
100	6.705760000			Bluetoot	33	0		Empty Data PDU
101	6.705985600			Bluetoot	33	0		Empty Data PDU
102	6.706248100			Bluetoot	39	6		LL Control PDU: LL_VERSION

```
DLT: 147, Payload: btle (Bluetooth Low Energy)
▼ Bluetooth Low Energy
    Access Address: 0x8e89bed6
  ▶ Packet Header
    Init Address: 74:e4:72:c6:ca:4e (74:e4:72:c6:ca:4e)
    Advertising Address: 57:23:d7:fe:b4:d9 (57:23:d7:fe:b4:d9)
  ▼ Connection Request
      Connection AA: 0xaf9a825d
      CRC Init: 0xf9a13e
      Window Size: 0x03
      Window Offset: 0x0006
      Interval: 0x0018
      Latency: 0x0000
```

```
0000  00 00 18 00 93 00 00 00  36 75 0c 00 00 62 09 00   ........ 6u...b..
0010  81 19 1c 08 80 7f 00 00  d6 be 89 8e c5 22 74 e4   ........ .....".t.
0020  72 c6 ca 4e 57 23 d7 fe  b4 d9 5d 82 9a af 3e a1   r..NW#.. ..]...>.
0030  f9 03 06 00 18 00 00 00  48 00 ff ff ff ff 1f a9   ........ H.......
```

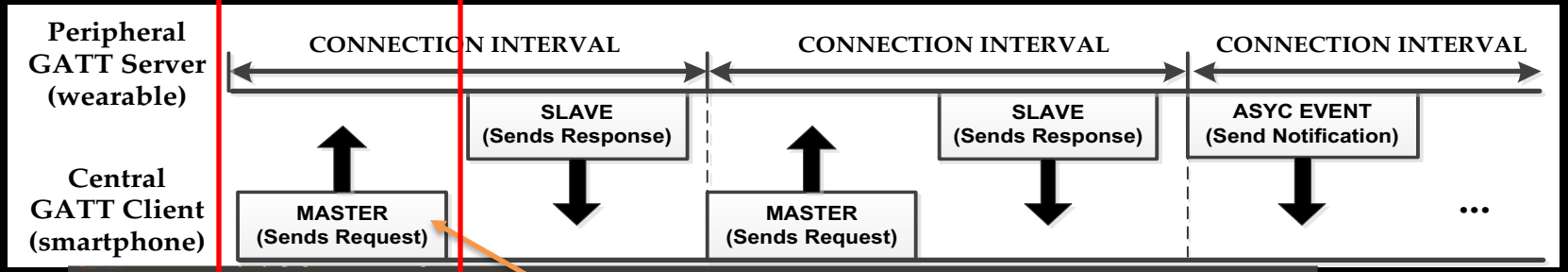
Capture this and you can follow a connection

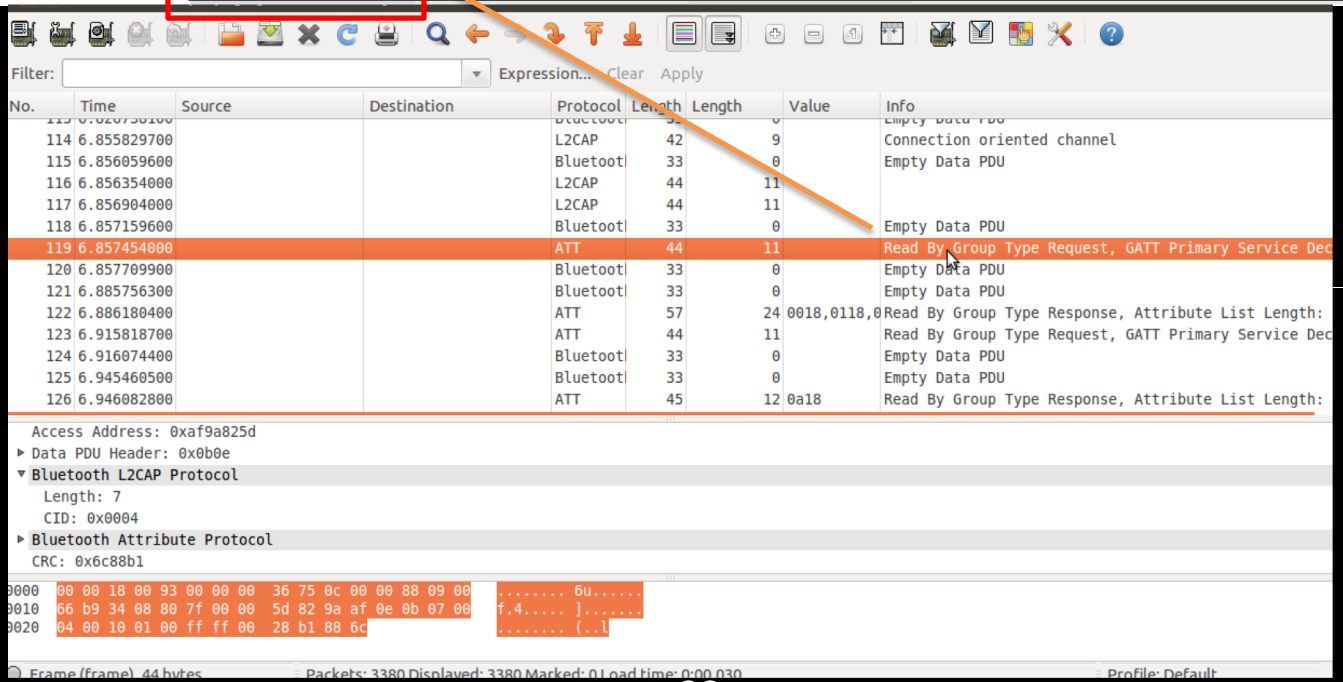
Sniffing Process



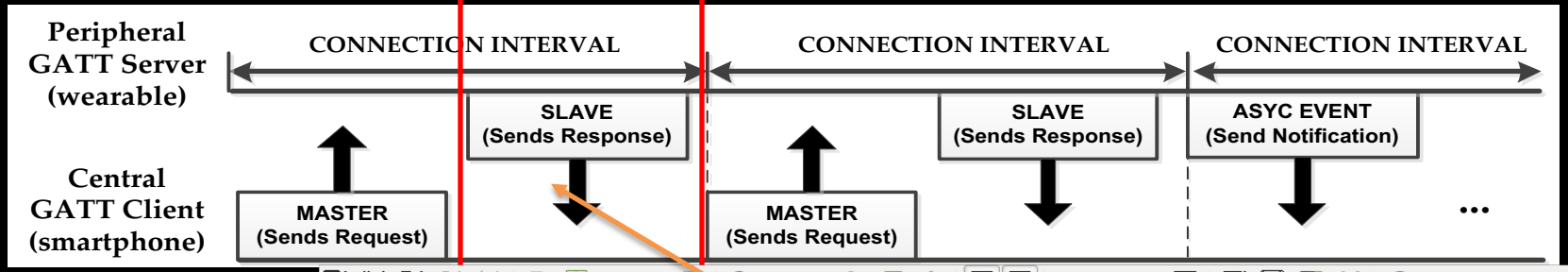
(after pairing)

Sniffing Process

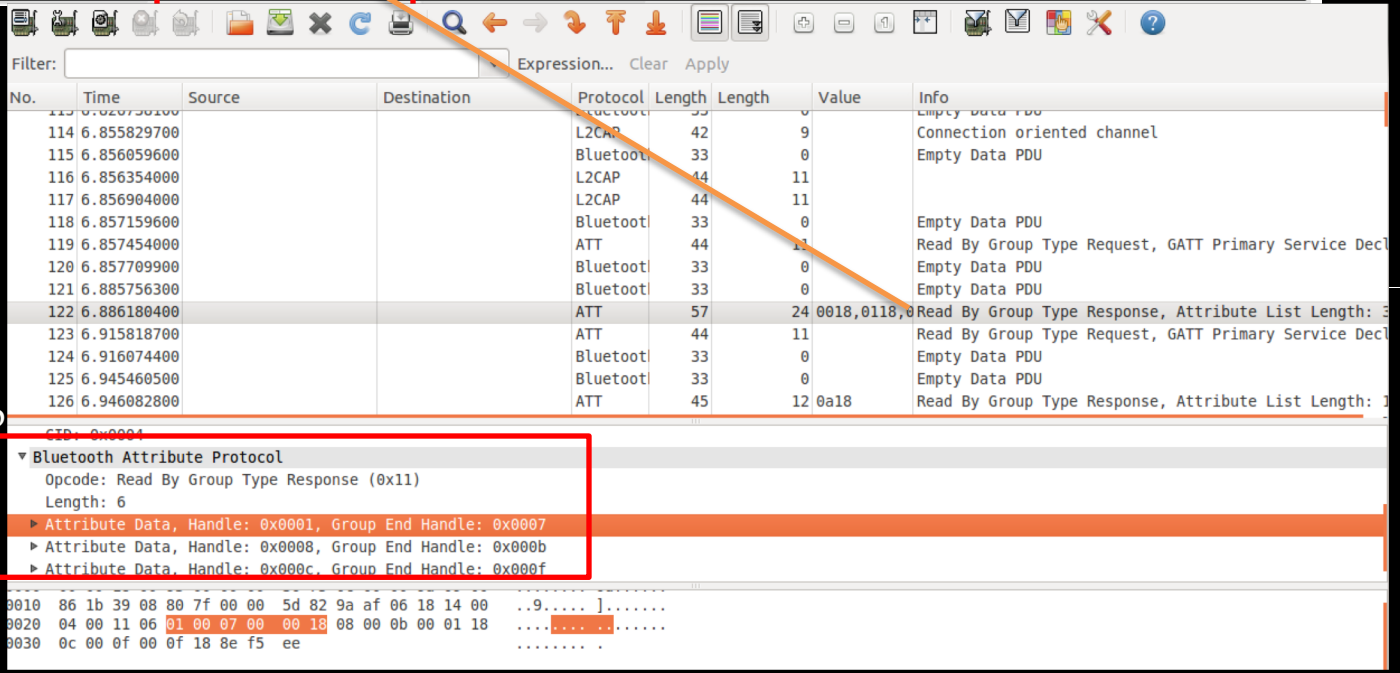




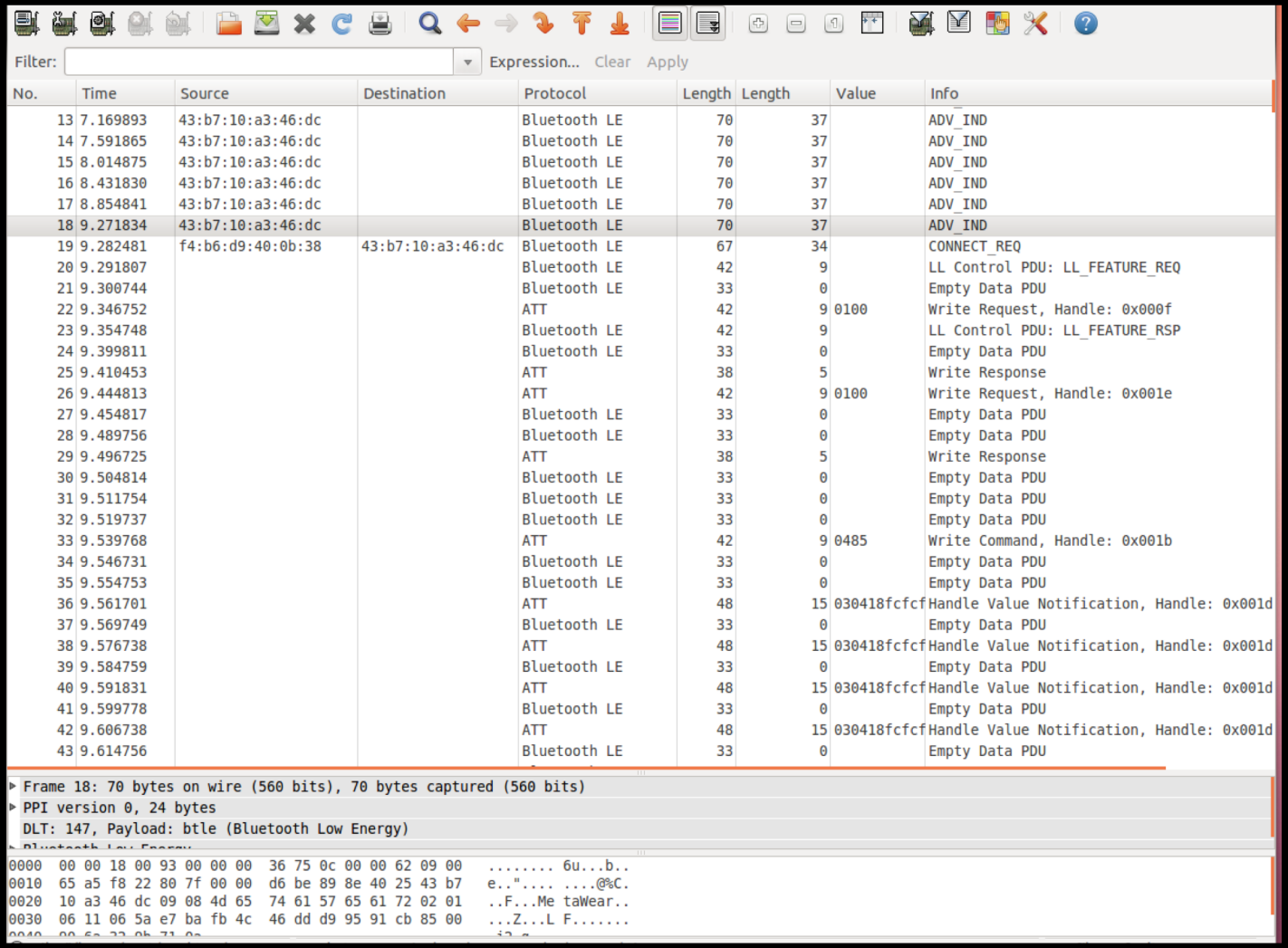
Sniffing Process



Some actual (accelerometer) data sent from MetaWear to our app



Sniffing Process



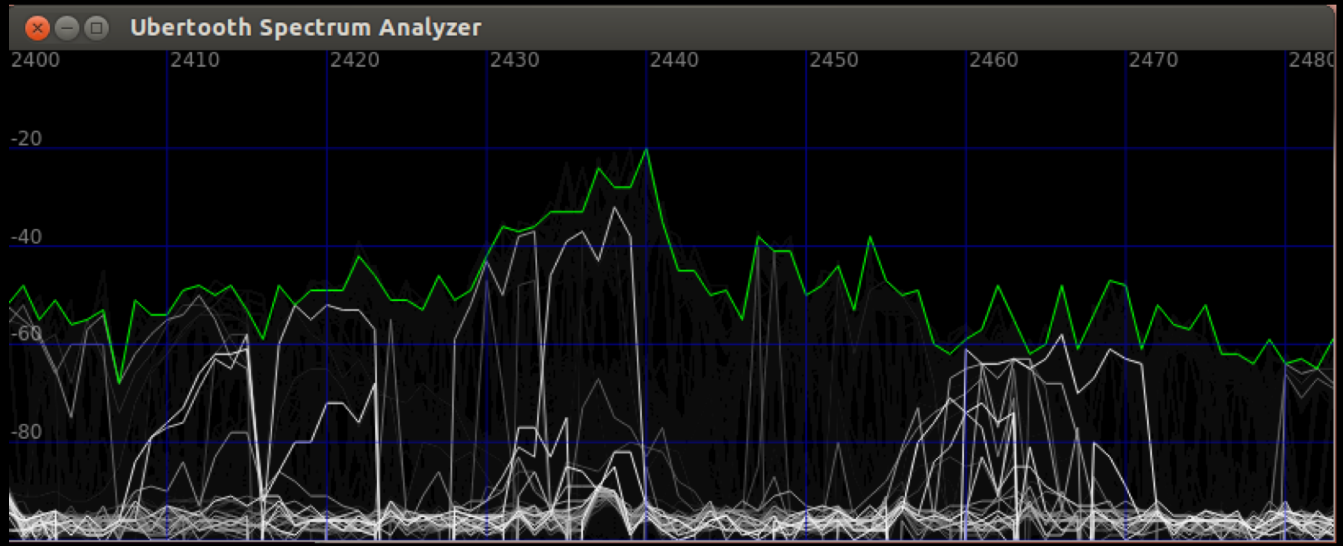
Filter: Expression... Clear Apply

No.	Time	Source	Destination	Protocol	Length	Length	Value	Info
13	7.169893	43:b7:10:a3:46:dc		Bluetooth LE	70	37		ADV_IND
14	7.591865	43:b7:10:a3:46:dc		Bluetooth LE	70	37		ADV_IND
15	8.014875	43:b7:10:a3:46:dc		Bluetooth LE	70	37		ADV_IND
16	8.431830	43:b7:10:a3:46:dc		Bluetooth LE	70	37		ADV_IND
17	8.854841	43:b7:10:a3:46:dc		Bluetooth LE	70	37		ADV_IND
18	9.271834	43:b7:10:a3:46:dc		Bluetooth LE	70	37		ADV_IND
19	9.282481	f4:b6:d9:40:0b:38	43:b7:10:a3:46:dc	Bluetooth LE	67	34		CONNECT_REQ
20	9.291807			Bluetooth LE	42	9		LL Control PDU: LL_FEATURE_REQ
21	9.300744			Bluetooth LE	33	0		Empty Data PDU
22	9.346752			ATT	42	9	0100	Write Request, Handle: 0x000f
23	9.354748			Bluetooth LE	42	9		LL Control PDU: LL_FEATURE_RSP
24	9.399811			Bluetooth LE	33	0		Empty Data PDU
25	9.410453			ATT	38	5		Write Response
26	9.444813			ATT	42	9	0100	Write Request, Handle: 0x001e
27	9.454817			Bluetooth LE	33	0		Empty Data PDU
28	9.489756			Bluetooth LE	33	0		Empty Data PDU
29	9.496725			ATT	38	5		Write Response
30	9.504814			Bluetooth LE	33	0		Empty Data PDU
31	9.511754			Bluetooth LE	33	0		Empty Data PDU
32	9.519737			Bluetooth LE	33	0		Empty Data PDU
33	9.539768			ATT	42	9	0485	Write Command, Handle: 0x001b
34	9.546731			Bluetooth LE	33	0		Empty Data PDU
35	9.554753			Bluetooth LE	33	0		Empty Data PDU
36	9.561701			ATT	48	15	030418fcfcf	Handle Value Notification, Handle: 0x001d
37	9.569749			Bluetooth LE	33	0		Empty Data PDU
38	9.576738			ATT	48	15	030418fcfcf	Handle Value Notification, Handle: 0x001d
39	9.584759			Bluetooth LE	33	0		Empty Data PDU
40	9.591831			ATT	48	15	030418fcfcf	Handle Value Notification, Handle: 0x001d
41	9.599778			Bluetooth LE	33	0		Empty Data PDU
42	9.606738			ATT	48	15	030418fcfcf	Handle Value Notification, Handle: 0x001d
43	9.614756			Bluetooth LE	33	0		Empty Data PDU

▸ Frame 18: 70 bytes on wire (560 bits), 70 bytes captured (560 bits)
▸ PPI version 0, 24 bytes
DLT: 147, Payload: btle (Bluetooth Low Energy)
▸ Bluetooth Low Energy

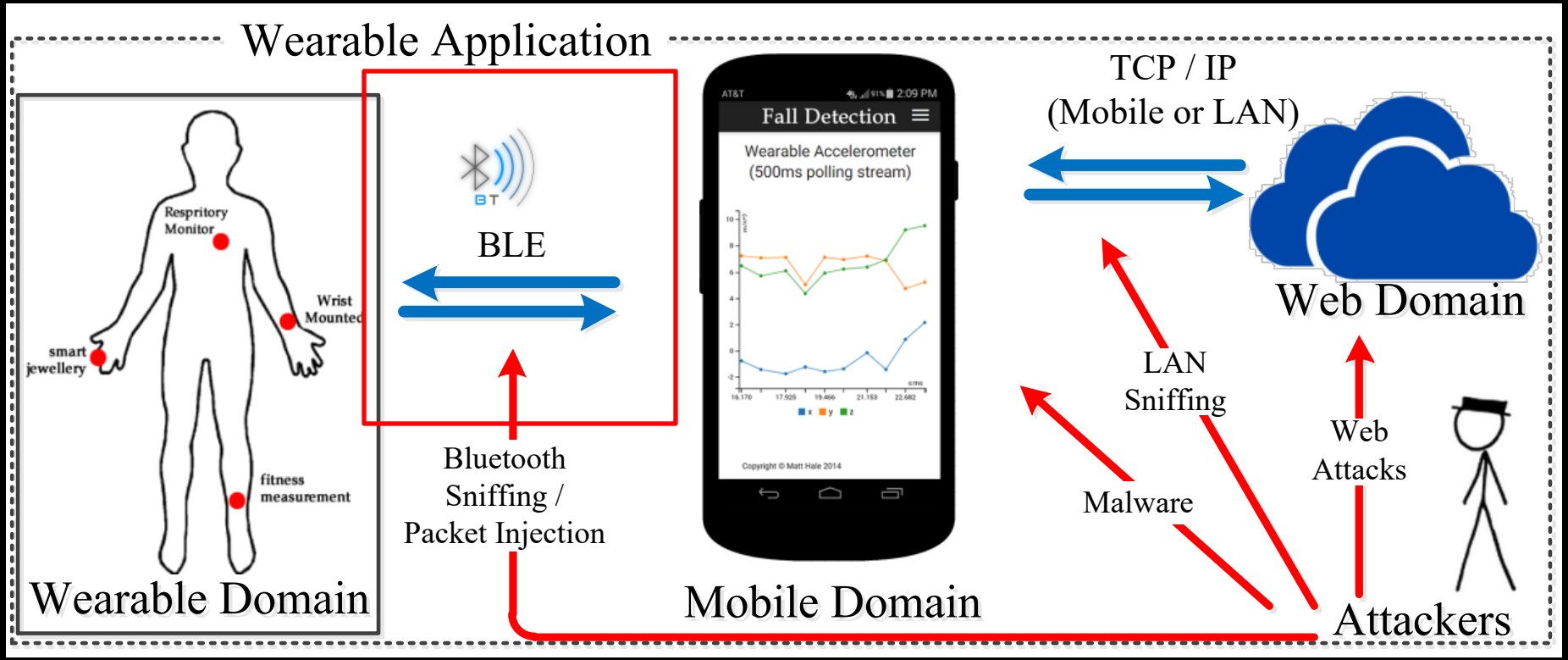
```
0000  00 00 18 00 93 00 00 00  36 75 0c 00 00 62 09 00   ........ 6u...b..
0010  65 a5 f8 22 80 7f 00 00  d6 be 89 8e 40 25 43 b7   e.."....  ....@%C.
0020  10 a3 46 dc 09 08 4d 65  74 61 57 65 61 72 02 01   ..F...Me taWear..
0030  06 11 06 5a e7 ba fb 4c  46 dd d9 95 91 cb 85 00   ...Z...L F.......
```

A Larger view of a Bluetooth PCAP file



Spectrum Analysis

DEMO


Wearable Application
Respritory Monitor
Wrist Mounted
smart jewellery
fitness measurement
Wearable Domain
BT
BLE
Bluetooth Sniffing / Packet Injection
AT&T
2:09 PM
Fall Detection
Wearable Accelerometer (500ms polling stream)
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Mobile Domain
TCP / IP (Mobile or LAN)
Web Domain
LAN Sniffing
Web Attacks
Malware
Attackers

Questions?

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Interdisciplinary Informatics

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