



Bluetooth: Technology and Applications

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2017.10.31

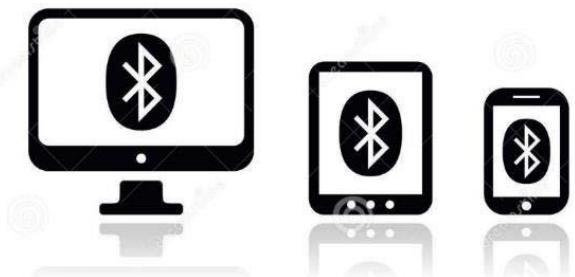
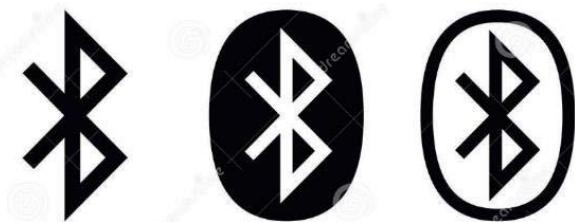
Main Contents



- 1 Bluetooth : What/When/Where**
- 2 Technology basics of Bluetooth**
- 3 Applications and Innovations**
- 4 Test and Authentication**

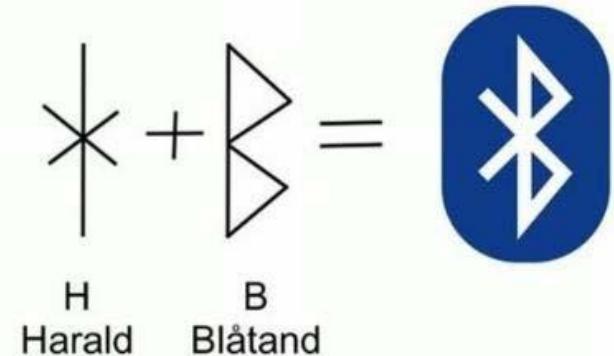
Bluetooth: What / Where

- Bluetooth
 - One of the most popular short-range wireless communication standard
 - Known as IEEE 802.15.1, now maintained by SIG (Special Interest Group)
- Bluetooth is everywhere
 - How many Bluetooth devices are there in the room?
 - Cellphones, wireless mouse/keyboard, smart watch/bracelet, earphone, ibeacon, ...



Bluetooth: The Name

- The name: Bluetooth
 - Harald Gormsson (935-985/6)
 - Aka. Harald Blåtand (Harald Bluetooth)
 - Likes to eat blueberries
 - King of Denmark and Norway
- Unites the Norway, Sweden and Denmark
- Eloquent, good at communication



Bluetooth: Born



- Invention
 - 1994
 - Ericsson
 - a wireless alternative to RS-232 cable
- Development
 - 1997-1998
 - Ericsson, Nokia, Toshiba, IBM, Intel
 - Ver 0.7, 0.8 proposed
- Publish
 - 1999
 - SIG (Special Interest Group) is founded
 - Microsoft, Motorola, Samsung, Lucent with SIG
 - Bluetooth 1.0 published



Bluetooth: The chronicle



Bluetooth 1.0

1998.10 – 2003. 11

“Base Rate”

- 1Mbps data rate
- V1.0 - Draft
- V1.0A - published on 1999.7
- V1.0B Enhanced the Interoperability
- V1.1 - IEEE 802.15.1
- V1.2 Enhanced the compatibility

Bluetooth 2.0 + EDR

2004. 11 – 2007. 7

“Enhanced Data Rate”

- Higher ordered modulation for data payload
- 2Mbps or 3Mbps physical data rate
- V2.0
- V2.1

Bluetooth 3.0 + HS

2009. 4

“HS Mode”

- AMP Alternative MAC/PHY
- Implement high data rate by using 802.11 protocols.
- Facing the Challenge from Wi-Fi
- V3.0

Bluetooth 4.0

2010. 6 – 2014. 12

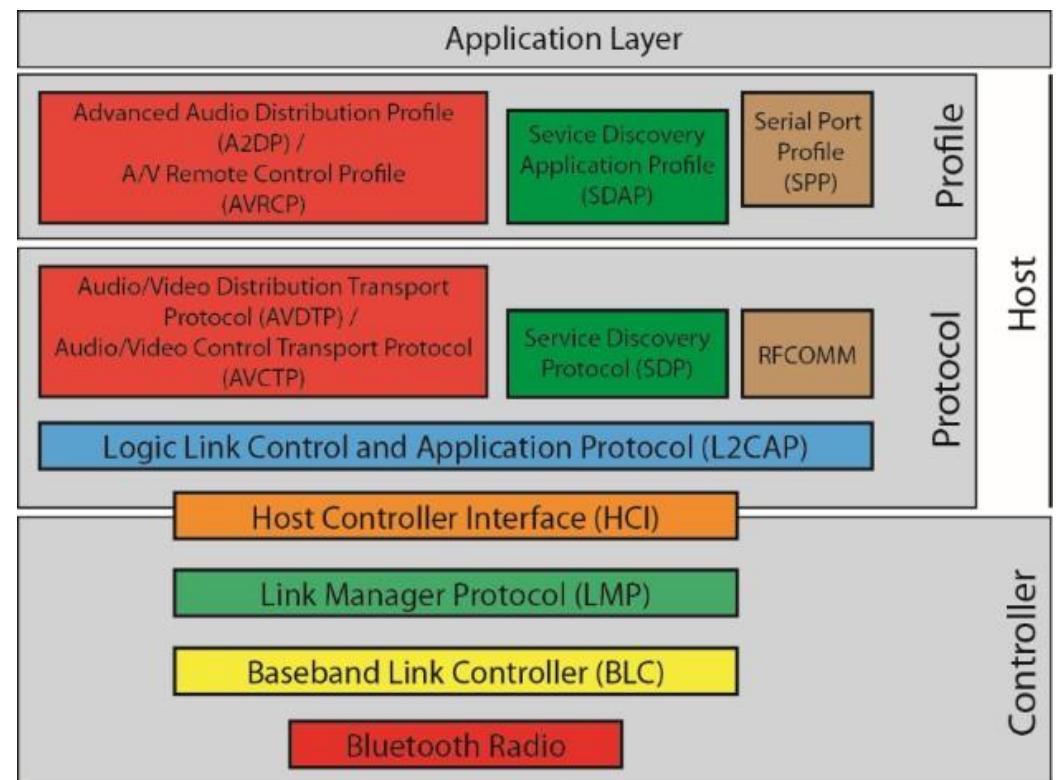
“Low Energy”

- Facing the IoT application
- Changed the protocol greatly, almost a new technology
- V4.0
- V4.1
- V4.2

Bluetooth: Protocol Stack



- Overview
 - Bluetooth protocol stack
 - Radio
 - Baseband
 - LMP
 - (HCI)
 - L2CAP
 - SDP
 - Optional Protocols and profiles supporting the application

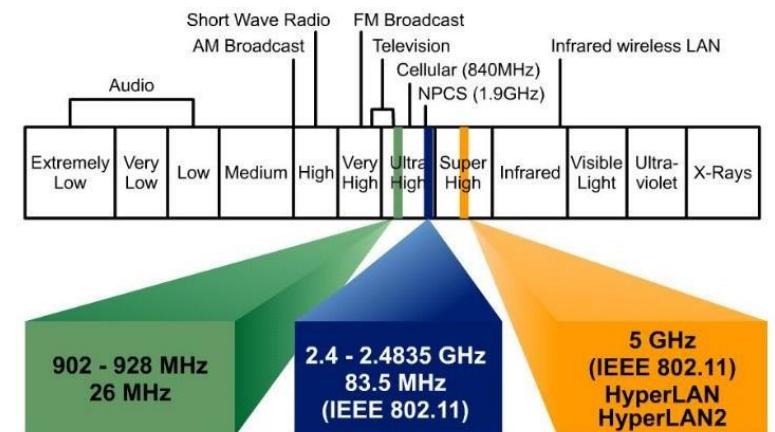


Bluetooth: Radio Band



- Radio Band

- Industrial, Science and Medical Radio Band
Aka. ISM Band 2.45G
- 2400MHz – 2483.5MHz
- Worldwide
- License Free
- Power Constrained



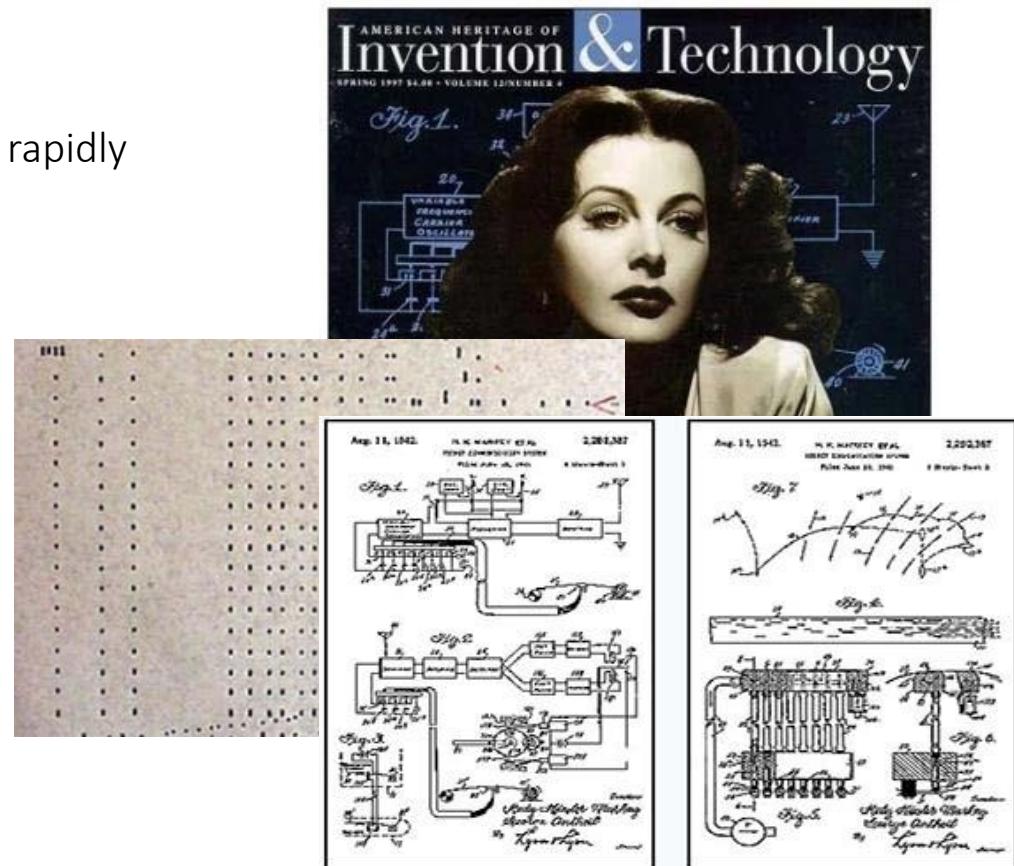
- Free to USE
- Coexistence: WLAN(802.11), Zigbee(802.15.4), ...
- Frequency hopping

Bluetooth: FH technology



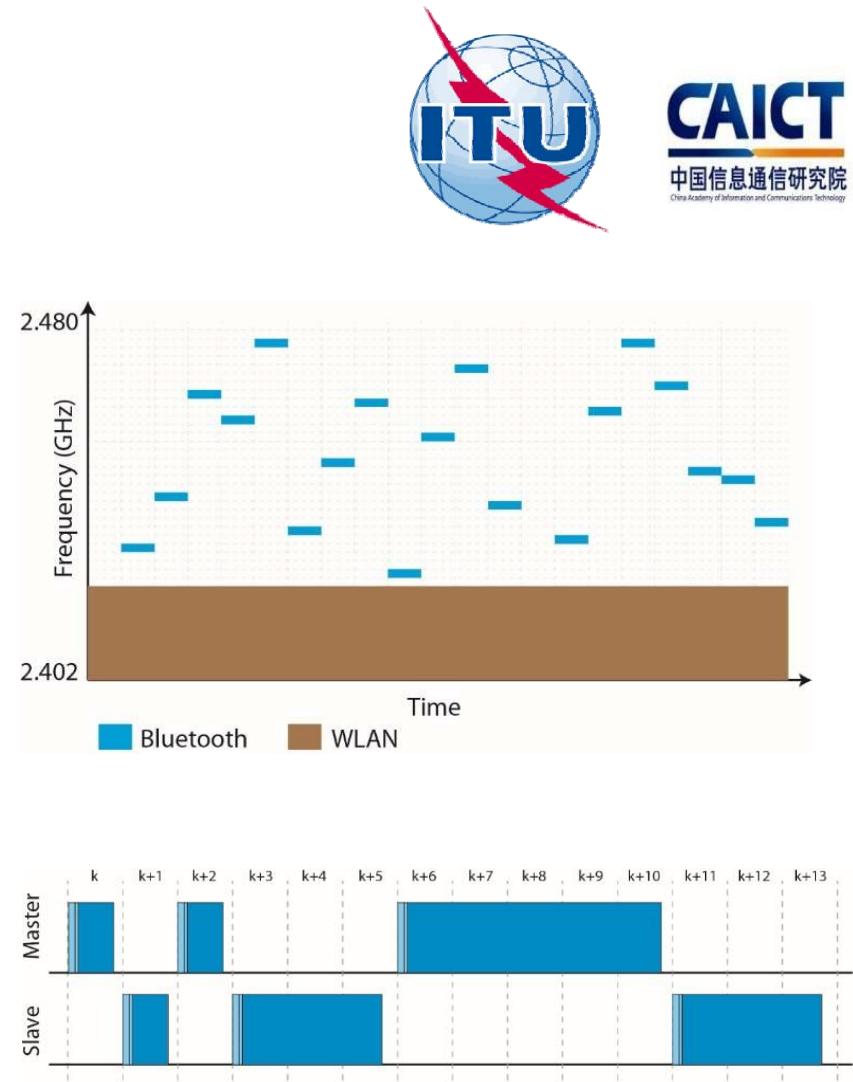
- Frequency Hopping

- A technology that spreads its signal over rapidly changing carrier frequencies
- Hedy Lamarr (1914 – 2000)
Movie Star and Inventor
- Made an auto piano with her husband
- Received a patent in 1942 on
Frequency Hopping
- “Secret Communication System”
Patent No. 2,292,387
- The patent expired in 1959
but no one used FH until 1962



Bluetooth: FH and Time Slot

- Frequency Hopping and Time slots
 - Fast. 1600 times / sec = 625us / slot
 - FH and AFH (Adaptive Frequency Hopping)
 - “Frequency Selection Kernel”
Complicated algorithm, sometimes treated as a Black Box
 - FH sequence based on the “Bluetooth CLK” and “Bluetooth Address” of the Master device
 - Single-slot Packet and multi-slot packets



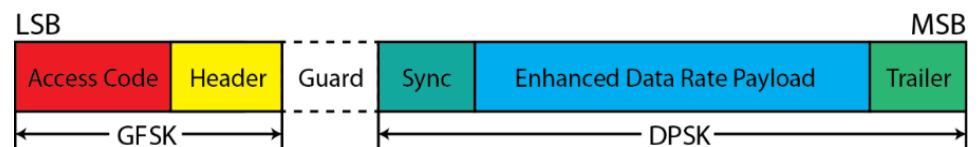
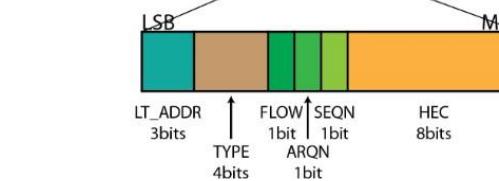
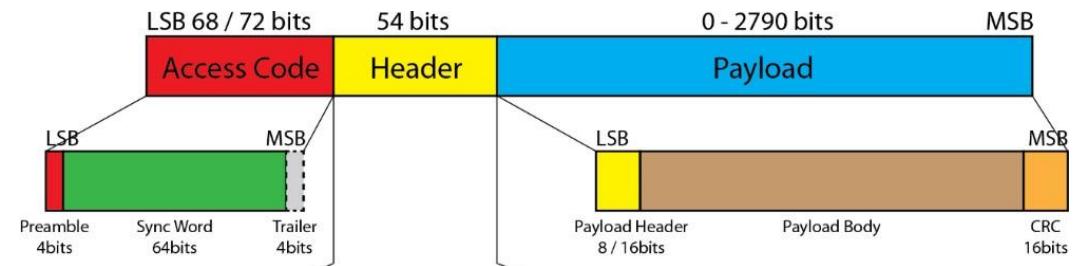
Bluetooth: Packets



- Bluetooth Packets

- Packets

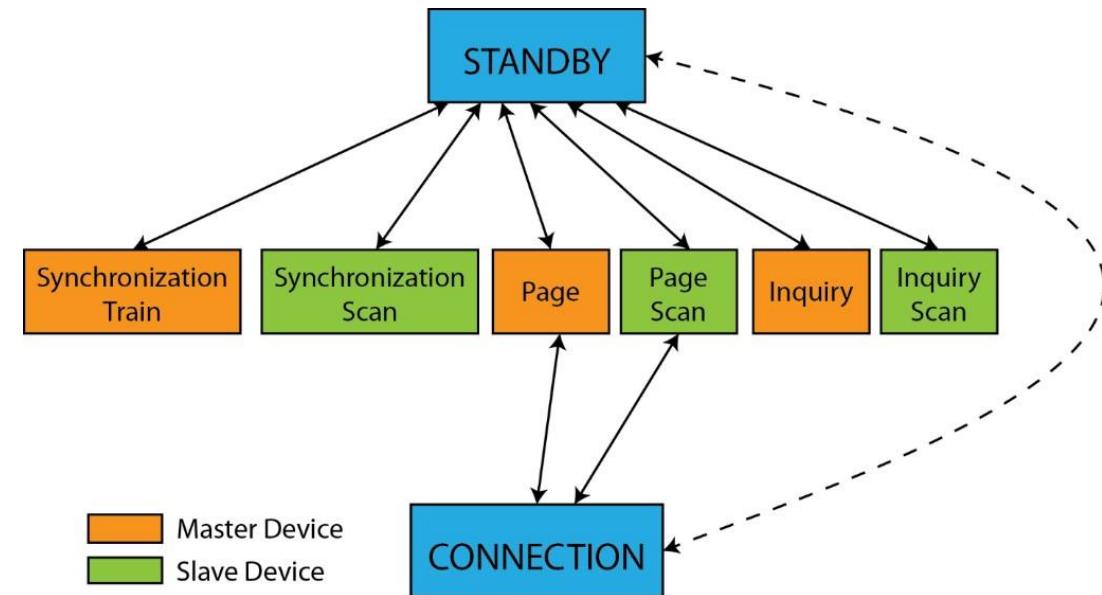
- Types
 - ID / FHS / DATA / Control
 - BR Packet
 - Access Code
 - Sync / Address
 - Header
 - Packet Type / Flow control
 - Payload
 - Data
 - EDR Packet
 - Guard
 - Sync
 - EDR Payload



Bluetooth: Connection



- Bluetooth Connection
 - Inquiry
 - Inquiry Scan
 - Page
 - Page Scan
 - Synchronization Train
 - Synchronization Response
 - Connection



Bluetooth: Logical transmission



- Bluetooth Data Packet Types / Logical Data Links
 - Error vs Delay
 - Which one is more concerned when we transmit data / signal?
 - CS vs PS
 - TCP vs UDP
 - SCO / eSCO
 - (Extended) Synchronous Connection-Oriented
 - ACL
 - (Asynchronous Connection-Oriented Logical

Bluetooth: Profiles

- Profiles
 - Regulations on application layer
 - “Optional”
 - CTP (Cordless Telephony Profile)
 - BPP (Basic Printing Profile)
 - SPP (Serial Port Profile)
 - FTP (File Transfer Profile)
 - PAN (Personal Area Network)
 - SAP (SIM Access Profile)
 - AV (Audio Video)
 - HS (Handset Profile)
 - ...



Bluetooth: Summary

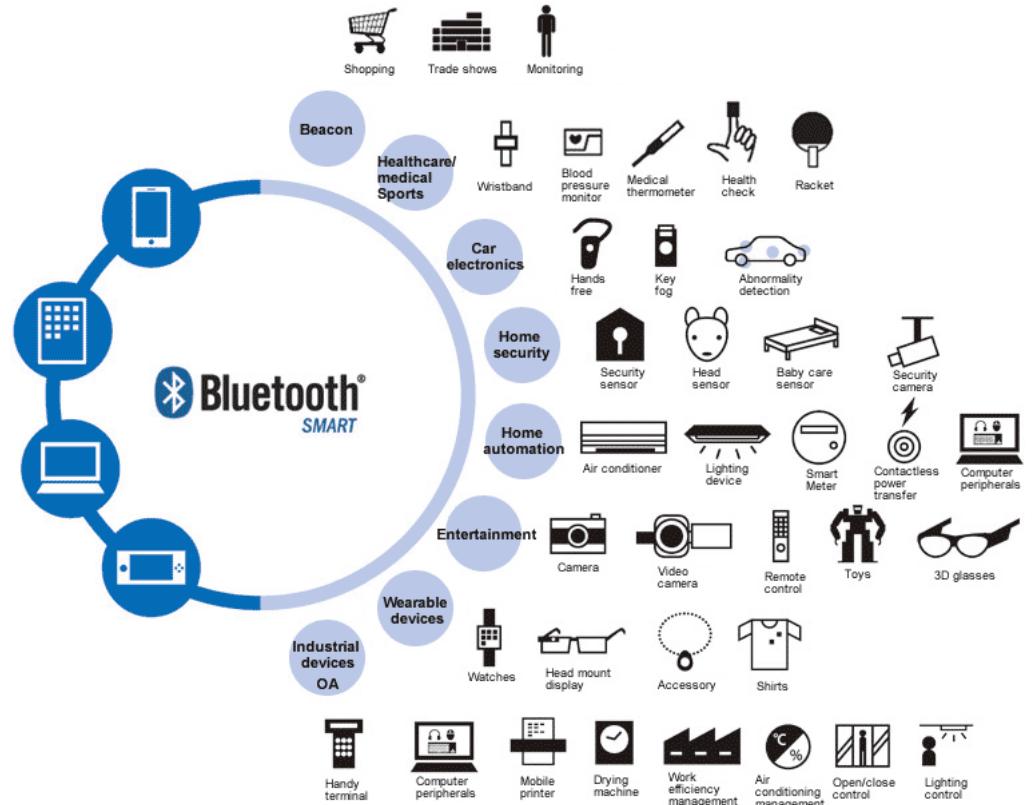


- **Classic Bluetooth Summary**
 - Replacing the cable
 - Emphasis speed and reliability
 - Transmission based on connected link
- **Advantages and disadvantages**
 - Speed – relatively high, especially with EDR
 - Suitable for applications which require high data rate and stability.
 - Music / File / Voice
 - Power consumption – High
 - To perform high Duty-cycle transmission
 - To maintain the Link

Bluetooth vs. BLE



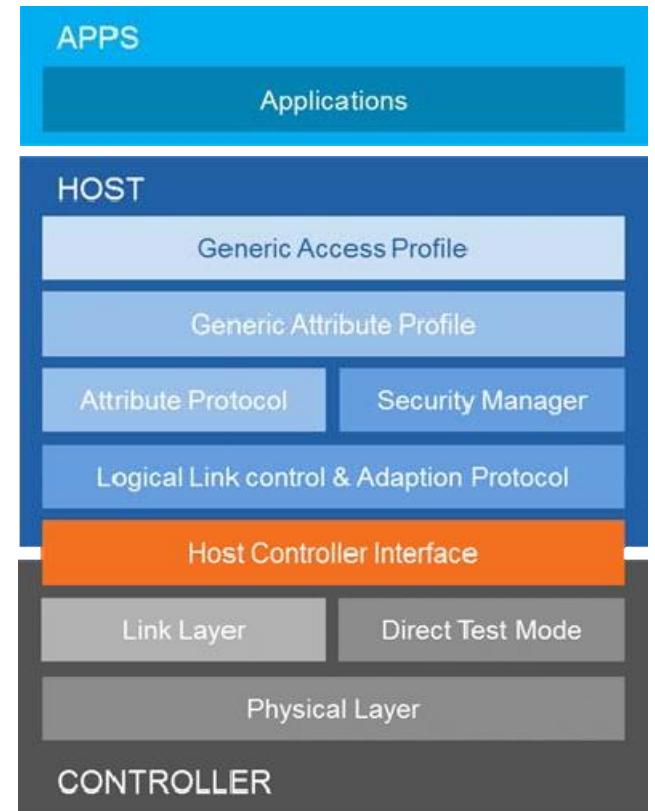
- What does IoT need?
 - An example: A sport bracelet
 - Small data packet
 - Burst transmission
 - Power consumption sensitive
- Similarities
 - Frequency band
 - Modulation
- Difference - Simplification
 - Smaller duty cycle
 - Shorter connecting time
 - Simpler packets
 - Connectionless advertising



BLE Protocols



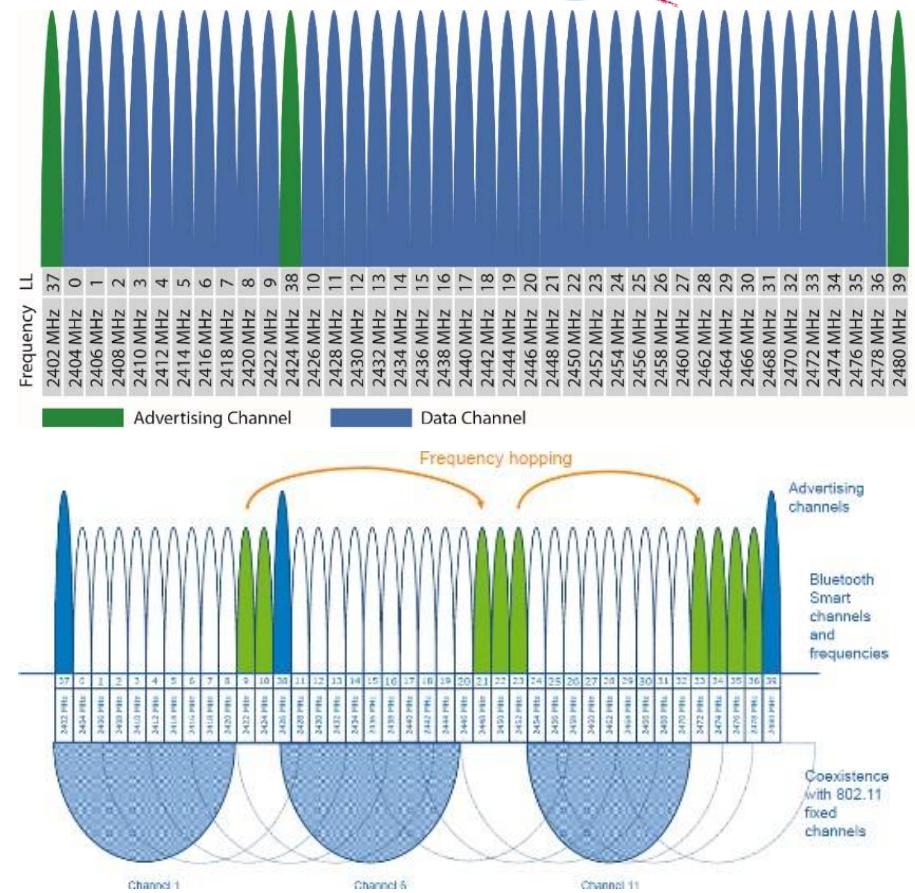
- **BLE Basic Logic**
 - Peripheral Device / Sensors have DATA
 - Central Device / Smartphones want to use DATA
 - Data / Readings peripheral -> central
 - Setting / Configurations central -> peripheral
- **How to pass the data?**
 - Advertising (Passive Scan) / Active Scan / Connection
- **How to organize the data?**
 - Profile / Service / Characteristic
 - Attribute / UUID



BLE – Band and Channels



- Frequency
 - Band division
 - 40 Band, 2MHz Each
 - 3 Advertising Channels and 37 Data channels
 - Frequency Hopping
 - Regular Hopping Sequence with given intervals
 - Adaptive – detect ‘used’ band to avoid interference



BLE – Advertising



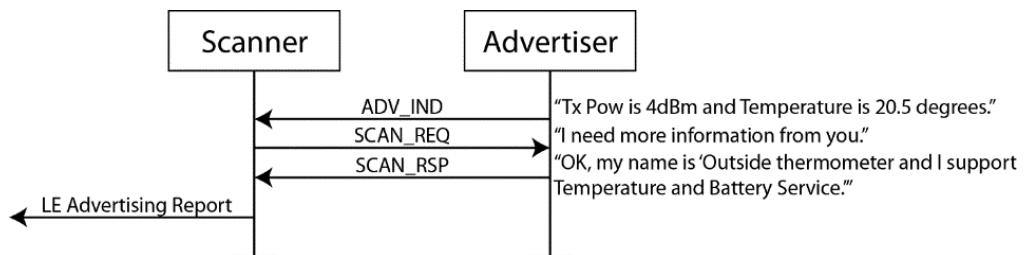
- Everything begins with advertising
 - Reporting the data / advertisement
 - Configurable channel / power / time interval
 - For broadcast or for connection
 - ADV_IND: Data and information “I can be connected, and can be scanned”
 - ADV_DIRECT_IND: Information “Only certain devices can connect to me.”
 - ADV_NON_IND: Data and information “I can be neither connected or response any scan”
 - ADV_SCAN_IND: Data and information “I will response some scan, but I can’t be connected”

BLE – Scan and connect

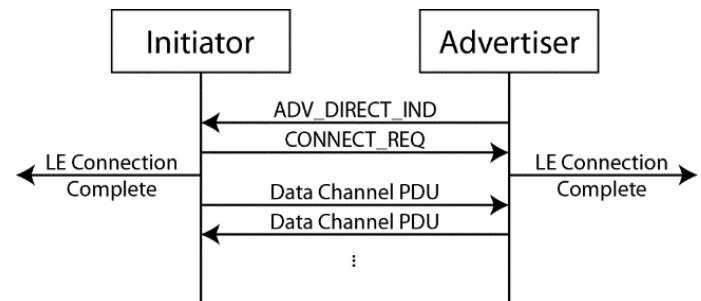


- Everything begins with advertising

- Passive Scan
- Active Scan
 - SCAN_REQ :
“I want more information”
 - SCAN_RSP:
“More information as you wish”



- Connection
 - CONNECT_REQ: “OK, let’s connect”
“Please follow these parameters:”
 - NO RESPONSE NEEDED!
 - In a blink around 3ms

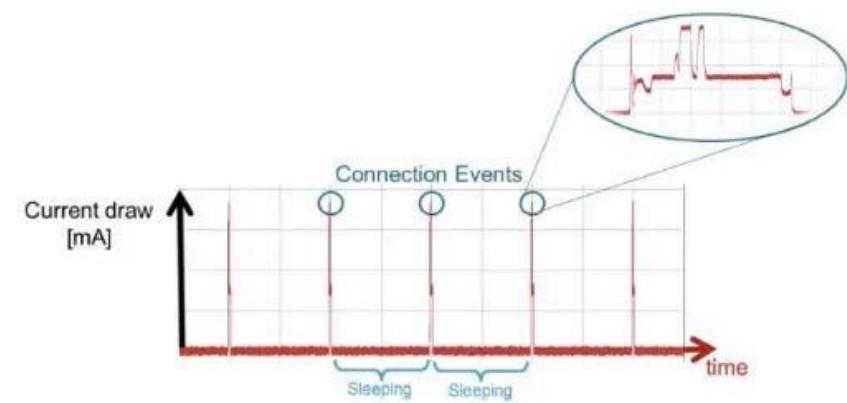
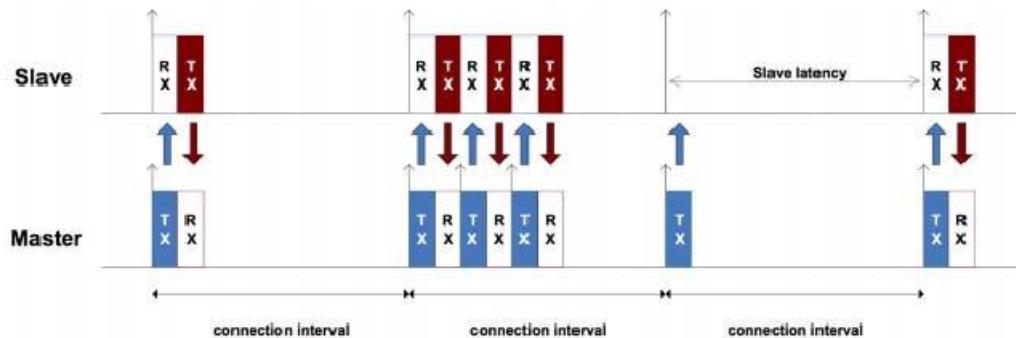


BLE - Connection



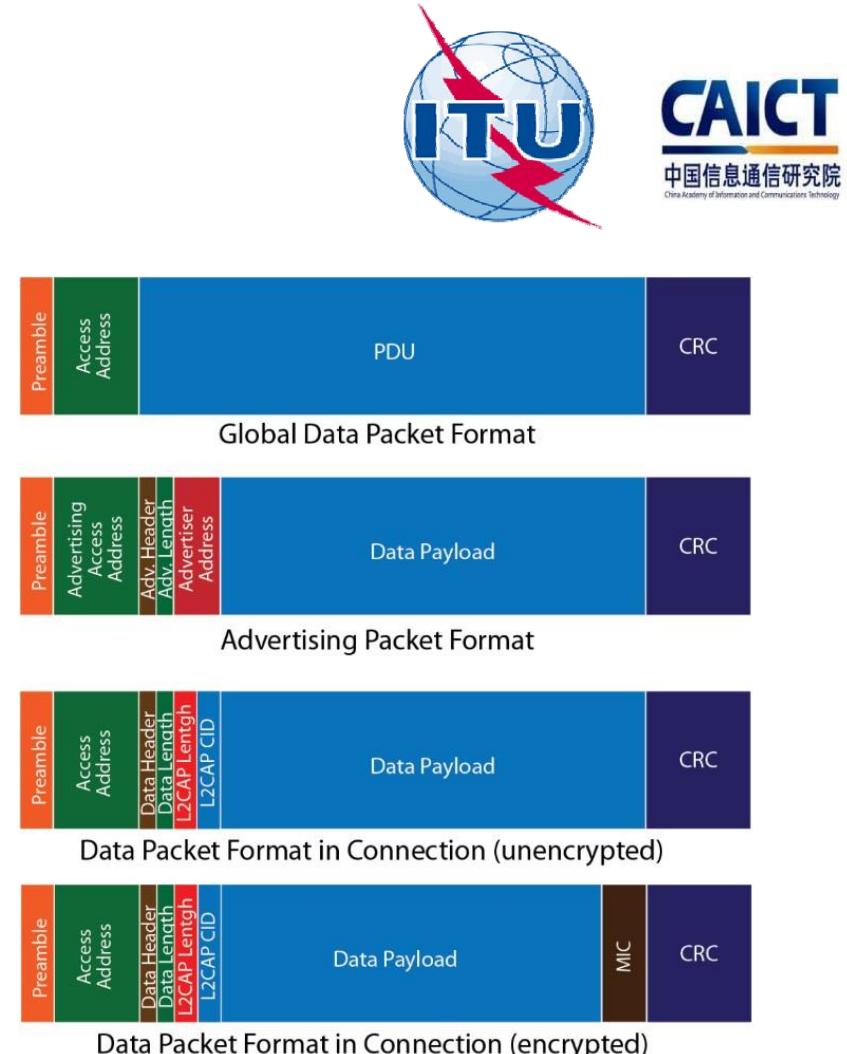
- BLE Connection

- Transmit application data reliably and robustly
- Connection Events / Connection Interval (7.5ms – 4s)
- Slave Latency (0 – 499)
- Connection supervision timeout (100ms – 32s)



BLE - Packets

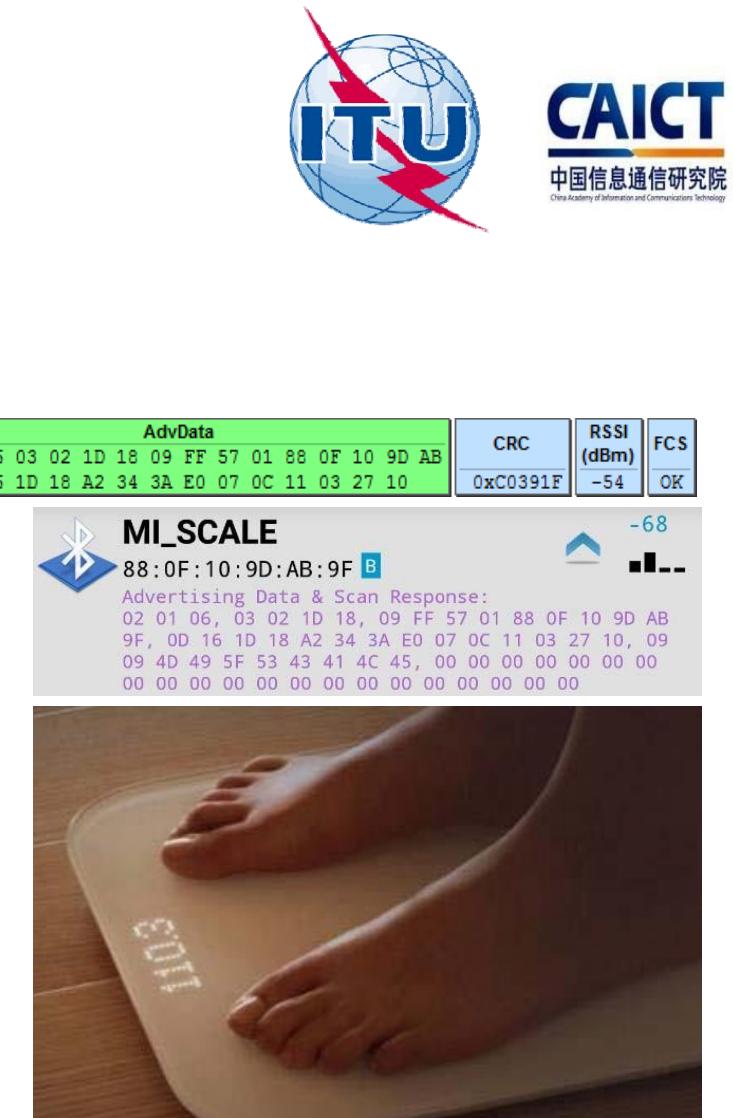
- Packets
 - Preamble
 - Access Address
 - Fixed '8E89BED6' for Advertising
 - PDU
 - Packet Data Unit
 - Follows regulations defined in GAP
 - AD structure: Length – type – data
- CRC
 - Checks the integrity of the packet



BLE Technologies

- An Example : Weight Scale
 - ‘Advertising Data Structure’
 - Length | Type | Data

P.nbr.	Time (us)	Channel	Access Address	Adv PDU Type	Adv PDU Header	Adva	AdvData	CRC	RSSI (dBm)	FCS
9	+1031101 =1031101	0x25	0xE8E9BED6	ADV_IND	Type TxAdd RxAdd PDU-Length 0 0 0 37	0x880F109DAB9F	02 01 06 03 02 1D 18 09 FF 57 01 88 OF 10 9D AB 9F 0D 16 1D 18 A2 34 3A E0 07 0C 11 03 27 10	0xC0391F	-54	OK
AD structure Type Content										
02 01 06	01: FLAG		0x06: 00000110: Support only LE connection							
03 02 1D 18	02: Service UID		0x181D: Weight Scale							
09 FF 57 01 88 0F 10 9D AB 9F	FF: Vendor Spec.		0x0157: Huami co., Ltd. 880F109DAB9F: Device Address							
0D 16 1D 18 A2 34 3A E0 07 0C 11 03 27 10	16: Service Data		0x181D: Weight Scale Service 0xA2: 10100010 SI units, Time stamp present, no user ID, no BMI 0x3A34: 14900 (x 0.005kg = 74.5kg) 0xE0070C11010203: 2016-12-17 03:39:16							
09 09 4D 49 5F 53 43 41 4C 45	09: Local Name (short)		0x4D 49 5F 53 43 41 4C 45: ‘MI_SCALE’							



BLE - Security



- BLE security
 - White List
 - Advertiser responds ONLY to devices with certain address
 - Valid address stored in a white list
 - Link Layer Privacy
 - Protect the address to prevent address faking
 - LE Encryption
 - AES-128 encryption
 - Protecting the content
 - (Higher level encryption)

BLE – Data exchange



- Key concepts in BLE
 - Profile
 - ‘An application’
 - Collection of services
 - Service
 - Collection of characteristics
 - Each has an unique ID (UUID)
 - Characteristic
 - A value with a known type and a known format
 - Also has an UUID
- Data exchange
 - Read / write the value of characteristics
 - May need authentication

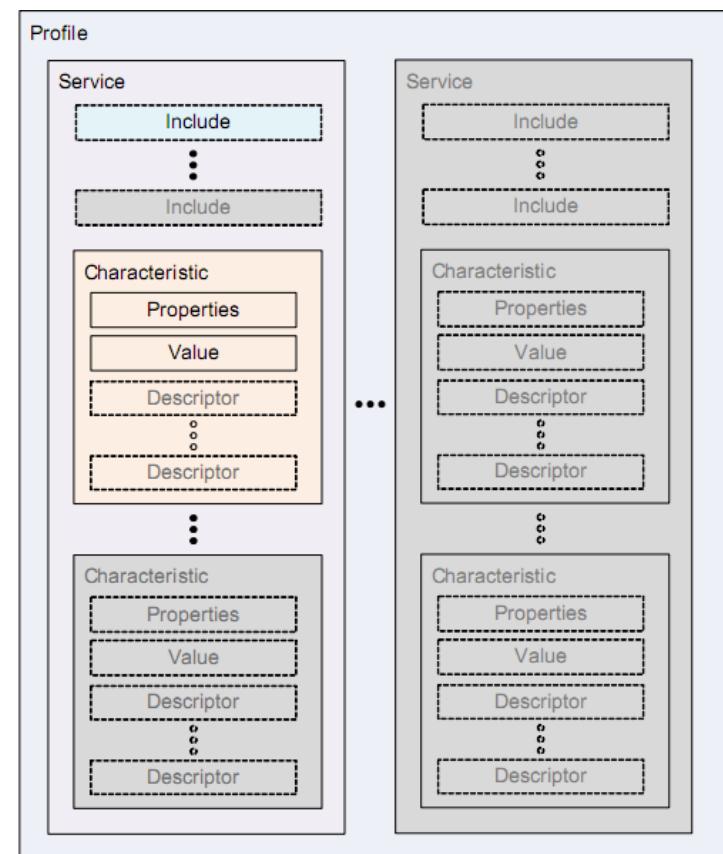


Figure 2.5: GATT Profile hierarchy

BLE Technologies

- An Example : a Heart Rate Monitor
 - Heart Rate Profile (HRP)
 - Device Information Service (0x180A)
 - ... (9 Characteristics)
 - Heart Rate Service (0x180D)
 - Heart Rate Measurement (0x2A37)
 - Body Sensor Location (0x2A38)
 - Heart Rate Control Point (0x2A39)



Name: Heart Rate Measurement

Type:

Name: Heart Rate Control Point

Type:

Value:

Name: Body Sensor Location

Type:

Value:

[org.bluetooth.characteristic.body_sensor_location](#) Download / View

Assigned Number: 0x2A38

Value Fields

Names	Field Requirement	Format	Minimum Value	Maximum Value	Additional Information
Body Sensor Location	Mandatory	8bit	N/A	N/A	Enumerations
					Key Value
					0 Other
					1 Chest
					2 Wrist
					3 Finger
					4 Hand
					5 Ear Lobe
					6 Foot
					7 - 255 Reserved for future use

Review: Why Bluetooth?



- BLE vs similar technologies

Variable	Wi-Fi	Z-Wave	Zigbee	Thread	BLE (V4.2)
Year first launched in market	1997	2003	2003	2015	2015
PHY/MAC Standard	IEEE 802.11.1	ITU-T G.9959	IEEE 802.15.4	IEEE 802.15.4	IEEE 802.15.1
Frequency Band	2.4GHz	900MHz	2.4GHz	2.4GHz	2.4GHz
Nominal Range @ 0dBm	100m	30-100m	10-100m	10-100m	30m
Maximum Data Rate	54 Mbps	40-100kbps	250kbps	250kbps	1Mbps
Topology	Star	Mesh	Mesh	Mesh	Scatternet
Power Consumption	High	Low	Low	Low	Low
Alliance	Wi-Fi Alliance	Z-Wave Alliance	Zigbee Alliance	Thread Group	Bluetooth Sig

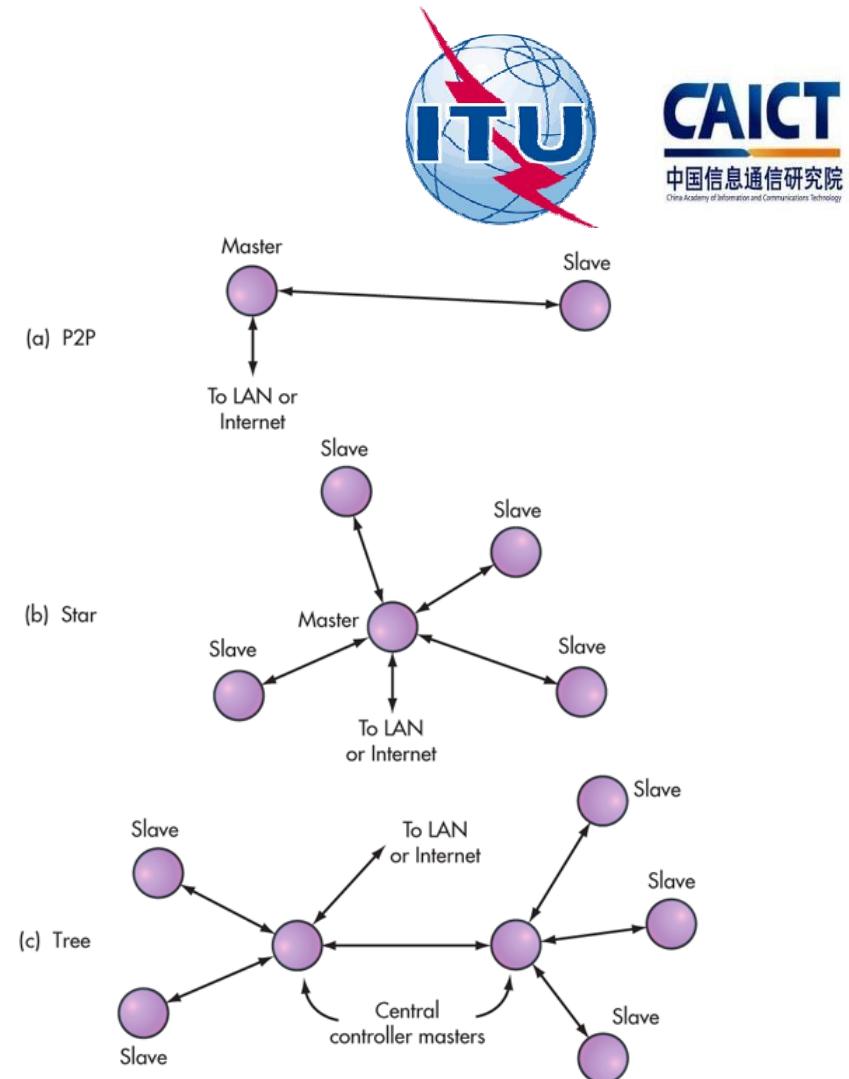
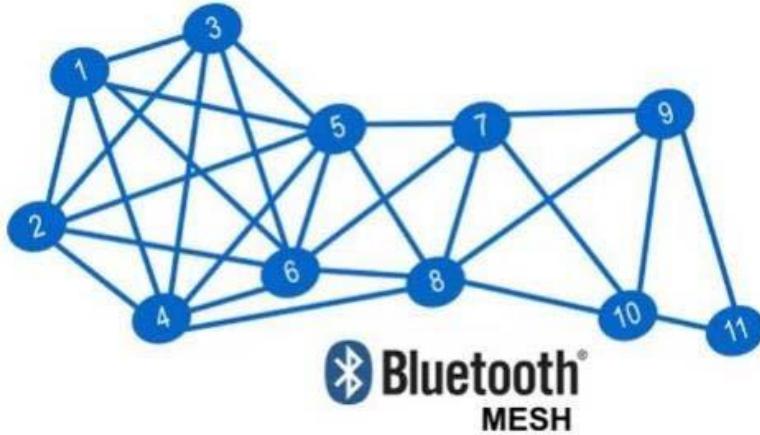
What's new?



- Bluetooth 5.0 (Released on Dec. 6, 2016)
 - “Shanghai”
 - New features
 - Longer
 - Tx power constraint relaxed
 - Channel coding applied
 - Faster
 - 2Mbps PHY Introduced
 - Greater
 - LE Advertising Extensions:
 - Logic Advertising Channel
 - Data Length 0 ~ 255 Bytes
- Bluetooth Mesh (Released in July, 2017)

BLE Technologies

- BLE Mesh
 - Mesh for IoT applications
 - Role of each node
 - Wireless Sensor Network
 - ‘Self-organizing network’



Bluetooth: Where?



- Application scenarios
 - Audio signal transmission
 - Bluetooth earphone
 - Bluetooth speaker
 - Multimedia system in vehicles



Bluetooth: Where?



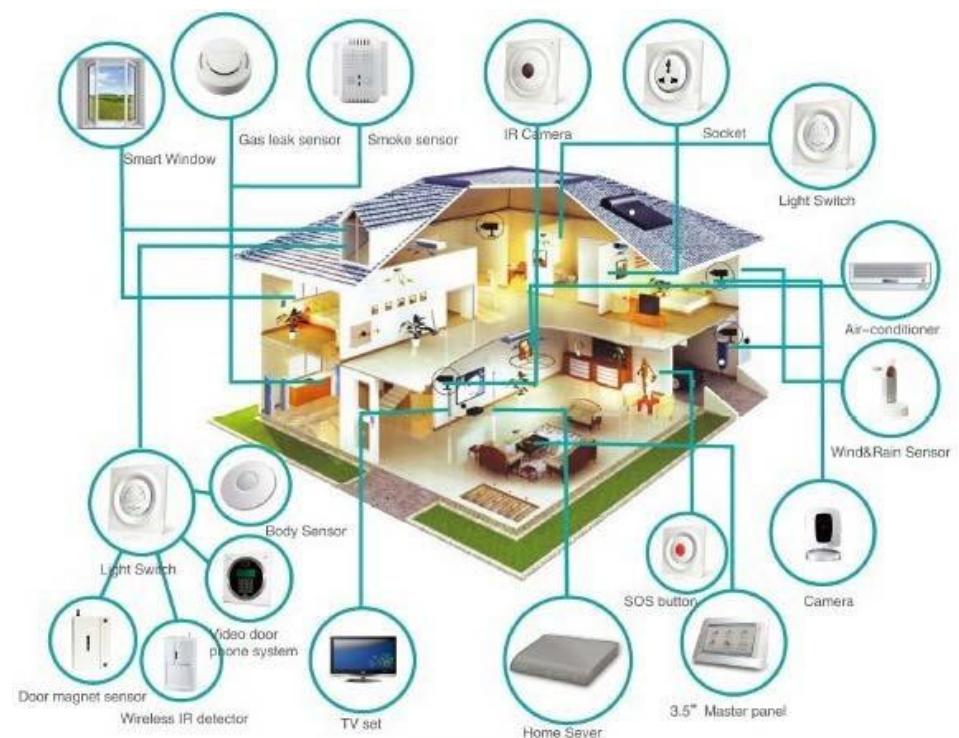
- Application scenarios
 - Industrial
 - Replacing the cable
The original thought of Bluetooth
 - SPP (Serial Port Profile)
 - Multi UART Port
 - Makes it easy to transfer data wirelessly to smart phones / PC
 - Makes it possible to upgrade parameter / program wirelessly
 - VERY LOW COST



Bluetooth: Where?

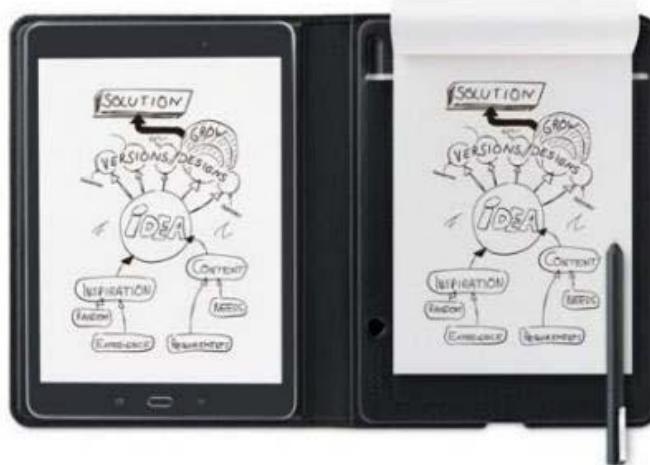


- Application scenarios
 - Smart home
 - Remote Control for A.C, TV, ...
 - Door Bell / Lock
 - Illumination
 - Music / Audio
 - Security
 - Valve for Water/Gas
 - Windows/Curtain
 - Power Socket



Bluetooth: Where?

- Application scenarios
 - Wearable devices
 - Smart bracelet
 - Smart watch
 - Smart shoes
 - Smart pen

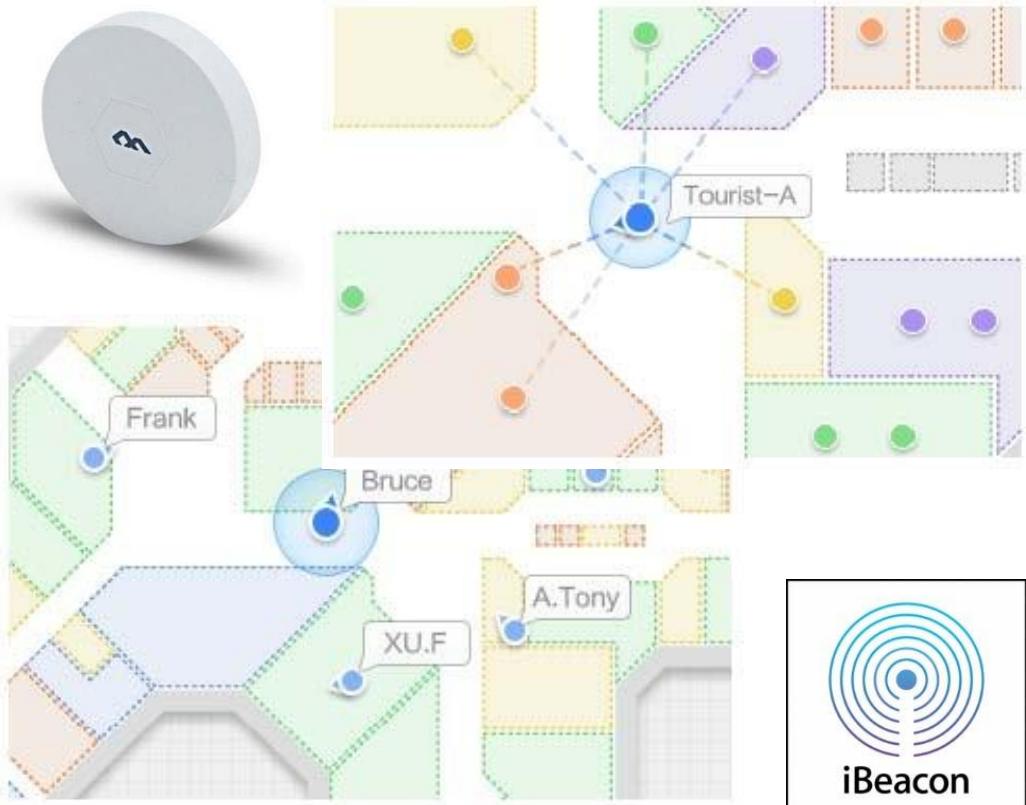
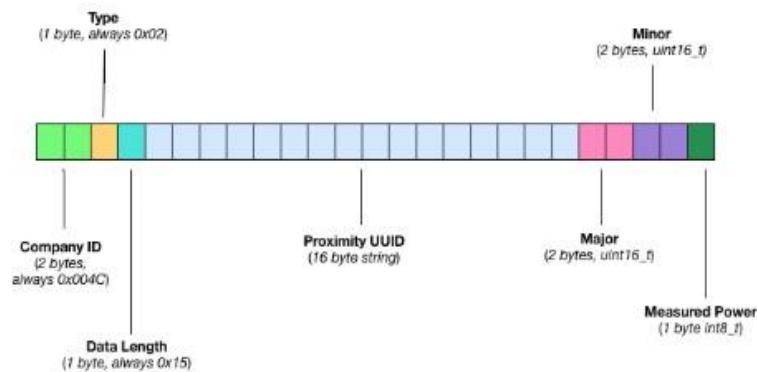


Bluetooth: Where?



- Application scenarios
 - BLE broadcast
 - Advertisement
 - In-door location
 - 'ibeacon'

iBeacon Manufacturer Data Format



Bluetooth: Where?

- Application scenarios
 - Other short range real-time communication
 - Barrier gate
 - Wireless mouse/keyboard
 - In-vehicle wireless Network
 - Shared Bicycles
 - ...



Test and Authentication



- Bluetooth Qualification Tests
 - Why?
 - For SIG
 - To protect the IP, and also protect the brand
 - For Manufacturer
 - To prove the product, and to get the permission
 - What?
 - TPG – Test Plan Generator
 - How?
 - TCRL – Test Case Reference List
 - TS – Test Specifications
 - BQE
 - Bluetooth Qualification Expert
- RF/RF-PHY Test
 - Verify the radio performance of the device
- Protocol Conformance Test
 - Verify the protocol conformance
- Profile Test
 - Too many types of Bluetooth devices
 - Profile defined
 - Profile Conformance Test
 - Profile Interoperability Test

Protocol Tests



- Classic Bluetooth Mandatory tests
 - BB (Baseband)
 - LM (Link Manager)
 - L2CAP (Logical Link Control and Adaptation Protocol)
 - SDP (Service Discovery Protocol)
 - GAP (Generic Access Profile)
- BLE Mandatory tests
 - LL (Link Layer)
 - GATT (Generic Attribute profile)
 - ATT (Attribute Protocol)
 - SM (Security Manage Protocol)
 - L2CAP (Logical Link Control and Adaptation Protocol)
 - GAP (Generic Access Profile)

Core — Test Requirements for v5.0 or later

Specifications	Test Specifications	ICS (Online ICS)	IXITs/Other	TCRL (Online TCRL)
802.11 MAC-PHY	802.11 MAC-PHY	ICS		TCRL
802.11 PAL	802.11 PAL	ICS		TCRL
A2MP	A2MP	ICS		TCRL
ATT	ATT	ICS	IXIT	TCRL
BB	BB	ICS	IXIT	TCRL
GAP	GAP	ICS	IXIT	TCRL
GATT	GATT	ICS	GATT Qualification Test DB IXIT	TCRL
HCI	HCI	ICS	IXIT	TCRL
L2CAP	L2CAP	ICS	IXIT	TCRL
LL	LL	ICS	IXIT	TCRL
LMP	LMP	ICS	IXIT	TCRL
RF	RF	ICS	IXIT	TCRL
RF-PHY	RF-PHY	ICS	IXIT	TCRL
SDP	SDP	ICS	IXIT	TCRL
SM	SM	ICS	IXIT	TCRL

SUM ICS - Appendix A to Declaration of Compliance: Summary of Selected Specifications in Implementation

Protocol Tests



- Test Instrument



Frame Display - BlackBerry - Plantronics 590.cfa

File Edit View Format Filter Options Window Help

Summary Hands-Free Baseband with Auto-traverse

Unfiltered | Baseband | Extended Inquiry Response | LMP | Bluetooth FHSS | SDCP | L2CAP | SDP | RFCOMM | AVDTP | AVDTP Signaling | AVDTP Media | Hands-Free | A2DP

B.	Frame#	Role	Add:	Hands-Free data	AT Cmd	Indication	Response	Fra.	Delta	Timestamp
0	451	S (HF)	1	AT+BFSE=24	Retrieve AG Supported Features			20		3/12/2009 4:33:28.205243 PM
1	453	M (AG)	1	-BRSF=350		Retrieved AG Supported Features	30	00:00:00.006875	3/12/2009 4:33:28.212119 PM	
2	454	M (AG)	1	.OK.		Success	23	00:00:00.003750	3/12/2009 4:33:28.215688 PM	
3	460	S (HF)	1	AT+CIND=?	Get supported indicators			29	00:00:00.474368	3/12/2009 4:33:28.690236 PM
4	462							136	00:00:00.011874	3/12/2009 4:33:28.702110 PM
5	463	*M (AG)	*1	*..+CIND: ("service"\[0-1\]),["call"\[0-1\]],["callsetup"]		Indicators supported	82	00:00:00.003750	3/12/2009 4:33:28.705860 PM	
6	464	M (AG)	1	.OK.		Success	23	00:00:00.002500	3/12/2009 4:33:28.708360 PM	

Frame 451 (Slave) Len=20

Baseband:
L2CAP:
RFCOMM:
Hands-Free:
 Role: Slave (Hands-Free Unit)
 Address: 1
 AT Command: Retrieve AG Supported Features:
 HF Supported features:
 EC and/or NR function: Not Supported
 Call waiting and 3-way calling: Not Supported
 CLU presentation capability: Not Supported
 Voice recognition activation: Supported
 Remote volume control: Supported
 Enhanced call status: Not Supported
 Enhanced call control: Not Supported

00110001 10001010 11000001 00001101 00000000 11010001 01111010 00000010 00000001 00001111 00000000
01000001 00000000 00001001 11011111 00010111 01000001 01010100 00101011 01000010 01010010 01010011
01000110 00111101 00110010 00110100 00001101 01000000
R 31 8a c1 0d 00 d1 7a 02 01 02 00 41 00 09 eE 17 41-54 2b 42-52-53 46-38-32-38-08-40
CHARACTER PANE
C 15 E C A D 0 E F F A 0 A 0 F F A T + B R S E = 2 4 % @

Total Frames: 19,262; Frames Filtered In: 19; Frame #s Selected: 451; (1 total)

Profile Tests



- Test on application layer
 - Checks the accordance with profile regulations
 - Core content from SIG
 - “Optional”

- Typical Profiles
 - A2DP (Advanced Audio Distribution Profile)
 - AVRCP (Audio Video Remote Control Profile)
 - CTP (Cordless Telephony Profile)
 - FTP (File Transfer Profile)
 - HFP (Hands Free Profile)
 - HID (Human Interface Device Profile)
 - HSP (Handset Profile)
 - LAP (LAN Access Profile)
 - PAN (Personal Area Networking Profile)
 - SPP (Serial Port Profile)
 - SDAP (Service Discovery Application Profile)
 - ...

Profile Tests



- Test device

- PTS (Profile Tuning Suite)
- Bluetooth Developer Studio
- Radio Module
- Provided only by SIG



The screenshot shows a laptop keyboard in the foreground, a smartphone displaying a test application in the middle ground, and a laptop screen in the background showing the PTS software interface. The software interface displays a tree view of profile parameters under "A2DP" and "AVB/CP", and a detailed configuration dialog for the "HFP" profile. The dialog lists several parameters with their values, including:

Parameter Name	Type	Value
TSPX_security_enabled	BOOLEAN	TRUE
TSPX_bd_addr_iv	OCTETSTRING	E42D02222ADD
TSPX_m_class_of_device	OCTETSTRING	200408
TSPX_mg_class_of_device	OCTETSTRING	400204
TSPX_packet_type_sco	OCTETSTRING	00AD
TSPX_phone_number	IASSTRING	1234567
TSPX_second_phone_number	IASSTRING	7654321
TSPX_phone_number_type	IASSTRING	129
TSPX_second_phone_number_type	IASSTRING	129
TSPX_phone_number_format	IASSTRING	The 3rd phone you are testing
TSPX_phone_number_memory	IASSTRING	9999
TSPX_scan_all_memory_dial	BOOLEAN	FALSE
TSPX_pin_code	IASSTRING	0000
TSPX_time_guard	INTEGER	300000
TSPX_use_implicit_send	BOOLEAN	TRUE

RF Tests



- Verification of Radio Performances
 - Transmitter Test
 - Output Power
 - Maximum output power
 - In-band Emission
 - Unwanted emission in ISM band
 - Modulation Characteristics
 - Frequency deviation when transmitting varieties of symbol combination
 - Carrier offset and drift
 - Initial offset of the carrier frequency
 - Long-term drift of the carrier frequency

- Receiver Test
 - Receiving Sensitivity
 - Minimum signal level for the receiver
 - Interference Tolerance
 - Carrier / Interference
 - Receiving Intermodulation
 - Blocking performance
 - Max receiving Power
 - Maximum signal level for the receiver
 - Report integrity
 - Verifies the Package Error Rate reported

RF Tests



- **Signaling test vs. non-Signaling test**
 - Signaling test – classic Bluetooth
 - DUT works in the normal working status
 - General controlling command and signaling used
 - Signaling interaction as usual
 - More complicated signaling and test set
 - Non-signaling test – BLE
 - DUT works in a dedicated 'Test Mode'
 - Test commands specially designed
 - Command and respond
 - Faster and lower cost

Task:

transmit '10101010' @ 2402MHz

Signaling Procedures:

1. Set the DUT into engineering mode
2. Page and connect the DUT
3. Stop the frequency hopping and set the channel to 2402MHz
4. Set the DUT into loopback mode
5. Transmit signal '10101010'
6. Wait for the loopback packet

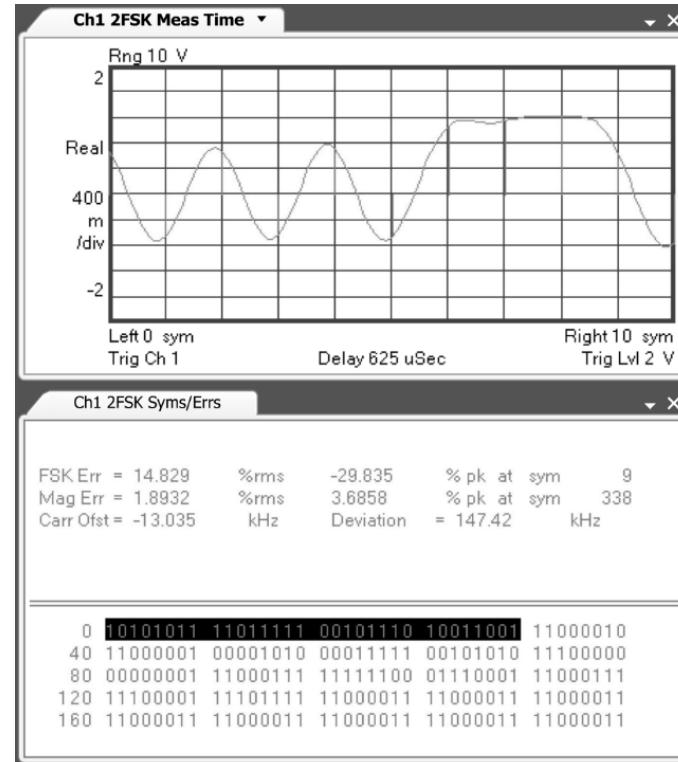
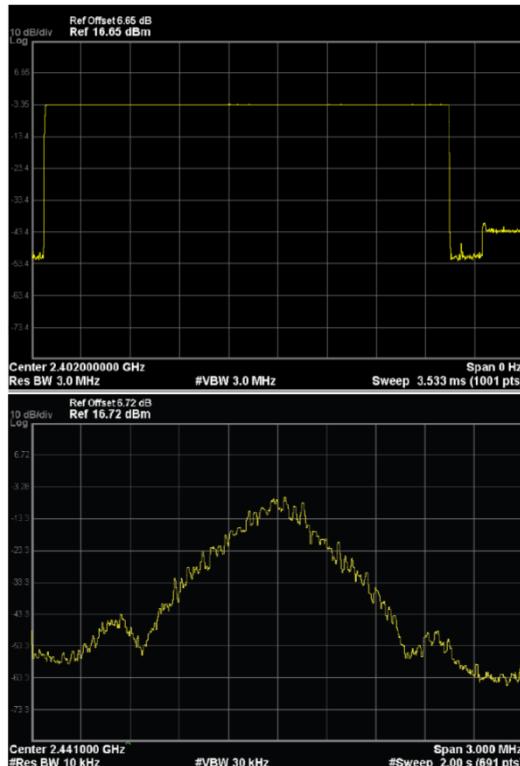
Non-signaling Procedures:

1. DUT entering Direct Test Mode
2. Tell DUT to send '10101010'@2402MHz

RF Tests



- RF tests



```
Receiver Sensitivity , Uncoded Data at 1Ms , Stable.log[3]
1 2017 03 29 - 16:12:23 Running Receiver Sensitivity , Uncoded Data
2 2017 03 29 - 16:12:23 E4438C Connected!
3 2017 03 29 - 16:12:23 RF Box #1 Connected!
4 2017 03 29 - 16:12:23 Path Switch Successfully!
5 2017 03 29 - 16:12:25 EUT Connected!
6 2017 03 29 - 16:12:48 Transmitter and Receiver Low Operating Freq
7 2017 03 29 - 16:12:48 Operating Frequency(MHz) : 2402
8 2017 03 29 - 16:12:48 PER(%) : 1.6
9 2017 03 29 - 16:12:48 Stage Verdict : Pass
10 2017 03 29 - 16:12:56 Transmitter and Receiver Middle Operating Freq
11 2017 03 29 - 16:12:56 Operating Frequency(MHz) : 2440
12 2017 03 29 - 16:12:56 Stage Verdict : Pass
```

3 Measurement Data

3.1 Low Operating Frequency

BER(%):	0.000
Packets Sent :	7408
Packets Received :	7408
Stage Verdict :	PASS

3.2 Middle Operating Frequency

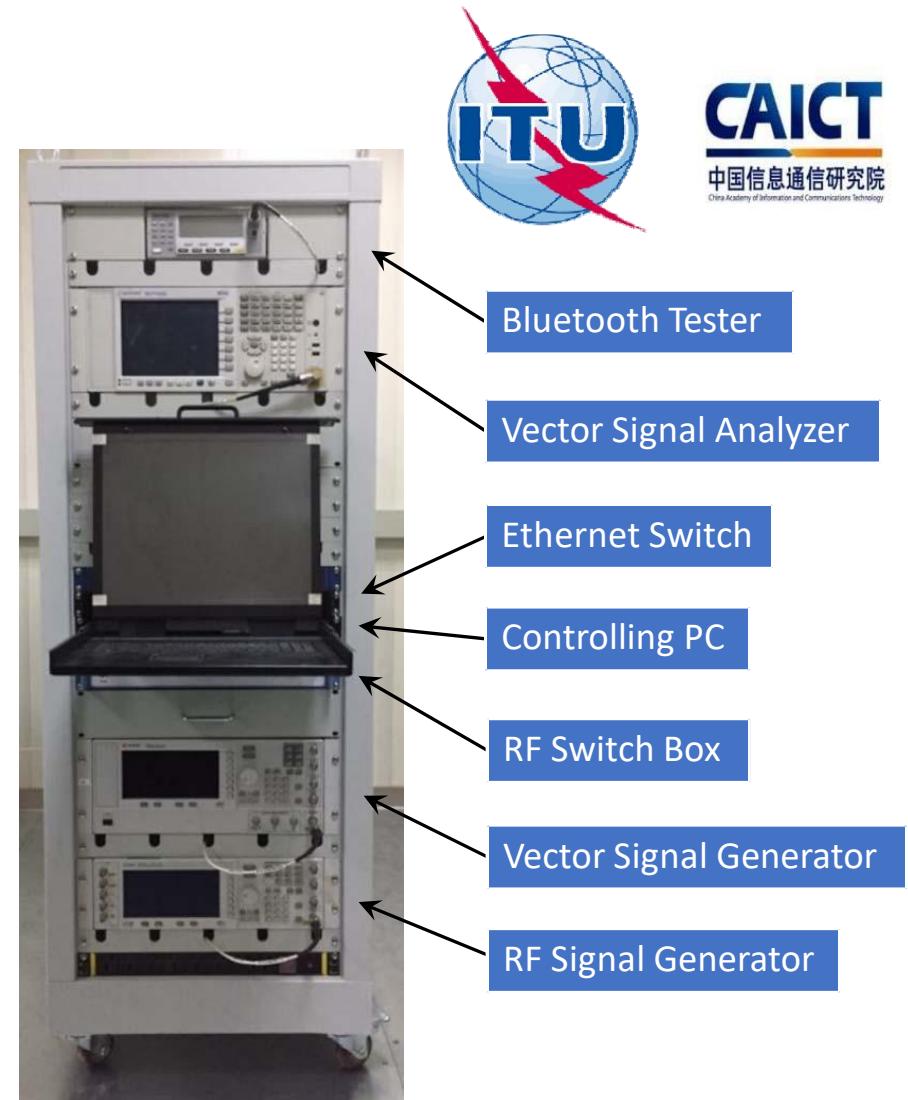
BER(%):	0.000
Packets Sent :	7408
Packets Received :	7408
Stage Verdict :	PASS

3.3 High Operating Frequency

BER(%):	0.000
Packets Sent :	7408
Packets Received :	7408
Stage Verdict :	PASS

RF Tests

- RF test equipment set
 - Bluetooth tester
 - Spectrum analyzer
 - RF signal generator
 - PC controller
 - RF switch box
 - ...



About CTTL - SYS

- China Telecommunication Technology Labs
 - Founded in 1981
 - Authoritative test organization
 - Supports the standards and regulation
- Main tasks
 - Information / Communication Technologies research
 - Development of ICT product standards and test methods
 - Products inspection, verification and assessment
 - Testing Instruments metrology and evaluation
 - 2G/3G/4G/Microwave Equipment
 - Antennas / RF Components
 - WPAN (Bluetooth, NFC, RFID, Zigbee, etc...)
 - Base products (Cables, Op. Fibers, accessories...)
 - Signal / Service Driver test
 - Power / Battery
 - Anti-seismic research and test
 - Metrology and calibration



About CTTL

- Our Bluetooth test solution



June 13, 2016

Test System Validation Decision

Validation is traceable results for supported test cases and conforms to the Bluetooth Specification.

The Bluetooth System - V1.1 Sheet, dated 1 (hereinafter "V1") System Validation

- Bluetooth
- Bluetooth
- Bluetooth

This decision is for:

- Bluetooth
- Bluetooth

The scope of this validation decision is:

The test system is instrumentational and compliant with the following specifications:

Bluetooth Specification, Part: RF, version 5.0 and earlier
Bluetooth Specification, Part: RF-PHY, version 5.0 and earlier

The scope of the validation decision is Test Platform and Test Case Implementation for Validated Parts.

After this decision CTTL-SYSTEMS may declare additional test cases validated within Validated Parts after the concurrence of the BTI. CTTL-SYSTEMS shall maintain validation material and make it available to Bluetooth Special Interest Group.

Bluetooth Specification Interest Group reserves the right to review validation status annually and at any time test system status has changed pertaining to validation requirements. The Bluetooth Specification



Test System Validation Decision

Test System Validation Decision

Thank You



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