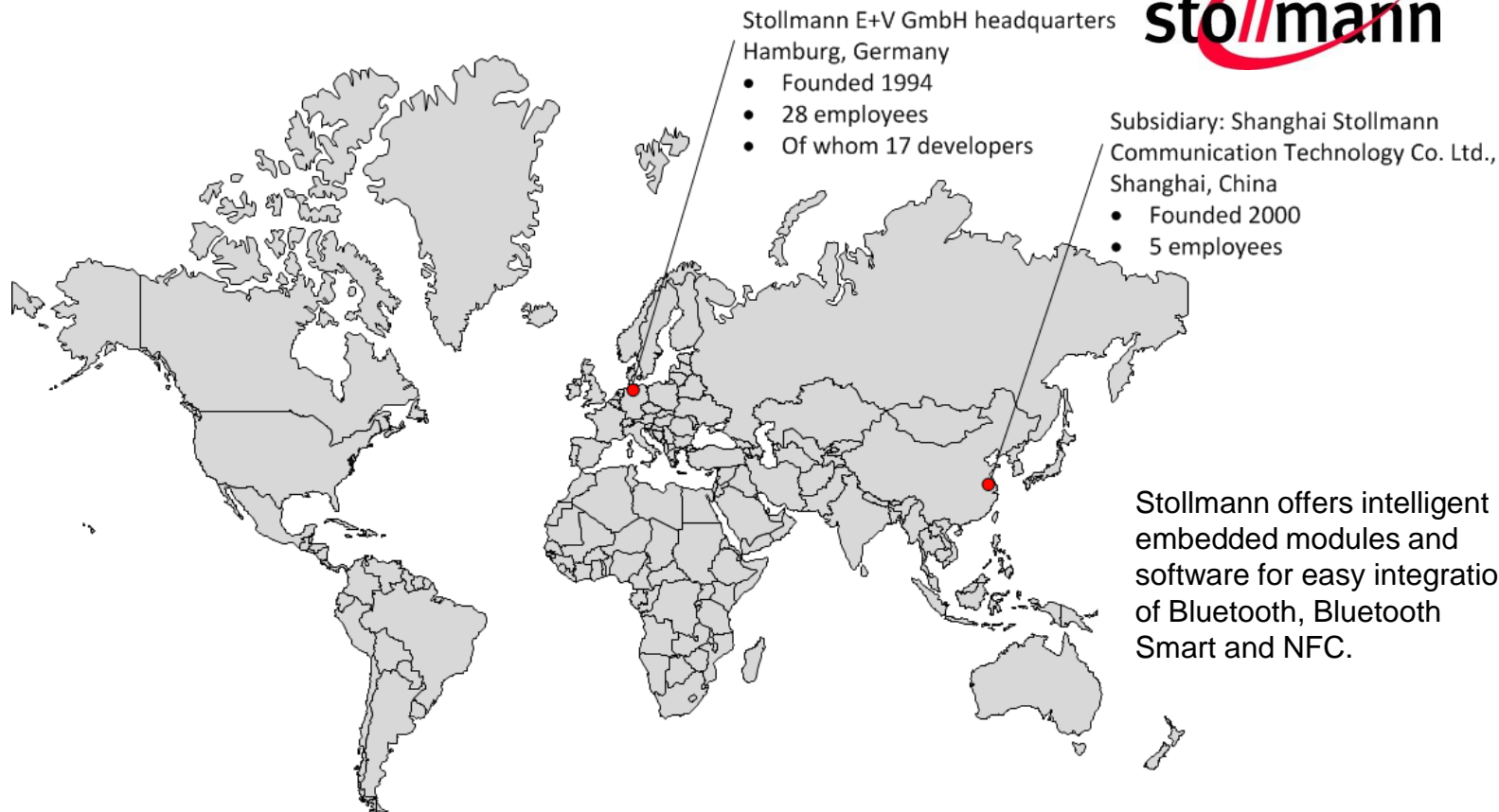


Bluetooth Integration Strategies into Embedded Systems

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Company



Stollmann offers intelligent embedded modules and software for easy integration of Bluetooth, Bluetooth Smart and NFC.

Bluetooth SIG Associate Member

NFC Forum Associate Member



Bluetooth and IoT

Wide variety of use cases

- in-home healthcare
- industrial networking
- automotive applications
- sports and fitness connectivity
- indoor positioning
- smart home



Bluetooth and IoT

IHS projects that Bluetooth enabled device shipments into the IoT will grow from 2.7 billion in 2014 to approximately 4.4 billion in 2019, or 36% of total IoT devices in 2019.

Industrial Electronics by Bluetooth Penetration
(Thousands of Units)

| | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | CAGR 14-19 |
|-----------------------------------|--------------|--------------|---------------|---------------|---------------|---------------|---------------|--------------|
| Industrial Electronics | 1,735,659 | 1,968,262 | 2,254,426 | 2,513,430 | 2,787,674 | 3,102,700 | 3,434,858 | 11.8% |
| Bluetooth Penetration (%) | 0.3% | 0.4% | 0.6% | 1.1% | 1.7% | 2.0% | 2.3% | |
| Bluetooth Device Shipments | 5,042 | 8,083 | 13,619 | 27,539 | 46,374 | 62,817 | 80,588 | 58.4% |

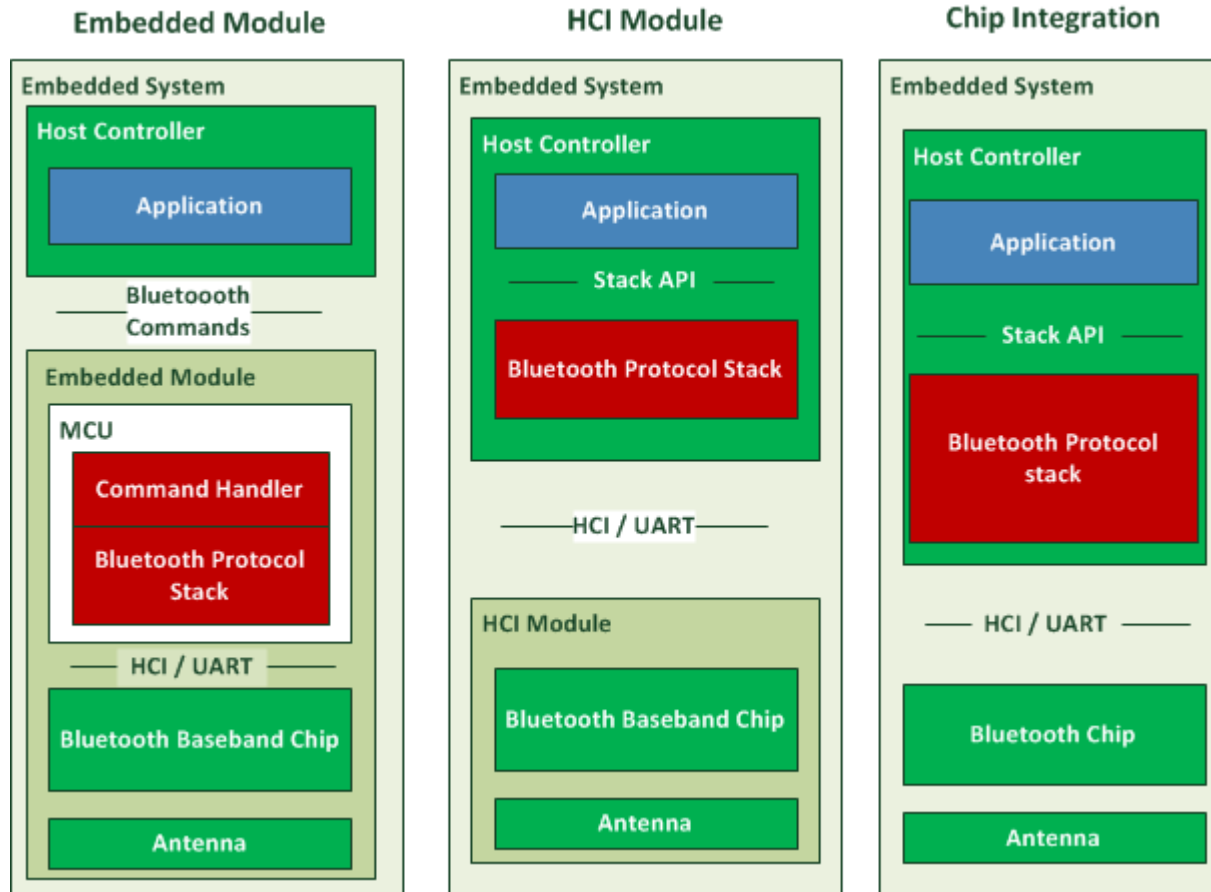
Source: May 2015

Bluetooth Features for IoT

- extremely low energy consumption
- very fast connection setup and disconnection
- available in nearly all smartphones, tablets and laptops around the world
- Smart Mesh
- IPv6 support
- highly configurable

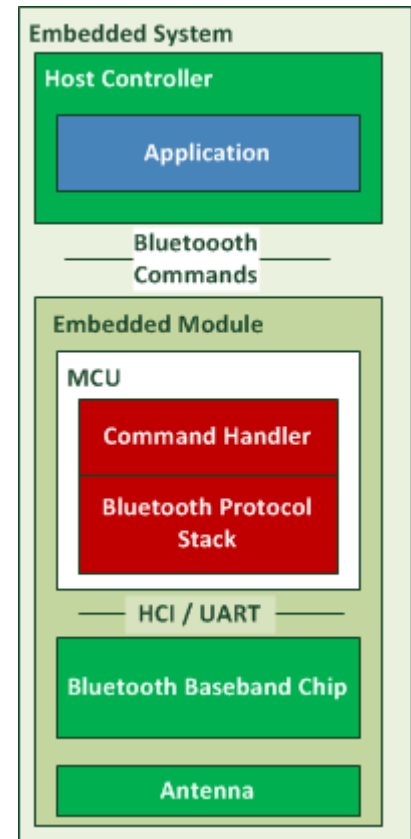
Bluetooth Integration

Three different integration strategies:



Embedded Module

Modules contain the Bluetooth baseband chip, a dedicated controller with protocol stack and antenna. They realize complete subsystem.



Embedded Module

Integration steps

- Place module on PCB
- Route power supply, UART and control
- Implement use case using module control commands in host controller software
- No routing if RF components
- No integration of Bluetooth protocol stack

Embedded Module

Advantages

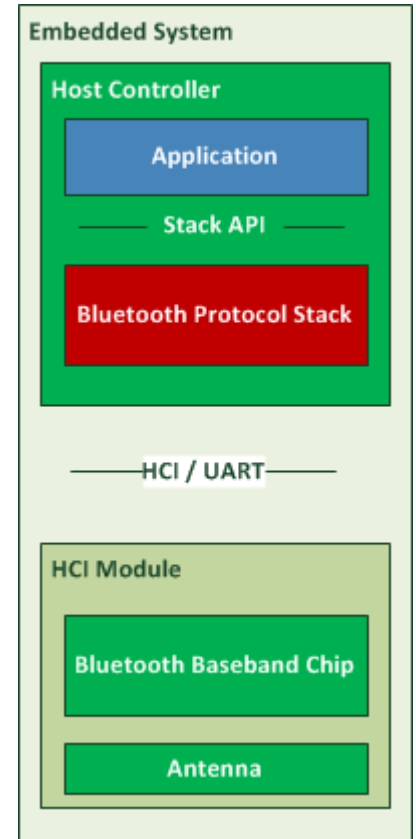
- Fast and simple integration
- Low integration cost
- No HW / SW Bluetooth know-how required
- Bluetooth qualified
- Country specific certifications available (e.g. FCC / IC)
- Easy integration on host system
- Low footprint (RAM/FLASH) on host system

Disadvantages

- Limited functionality
- Higher BOM cost

HCI Module

HCI modules are pure radio modules with Bluetooth baseband chip and antenna.



HCI Module

Integration steps

- Place module on PCB
- Route power supply, UART and control
- Port Bluetooth protocol stack to host controller system
- Implement use case using Stack API in host controller software
- No routing of RF components reqd

HCI Module

Advantages

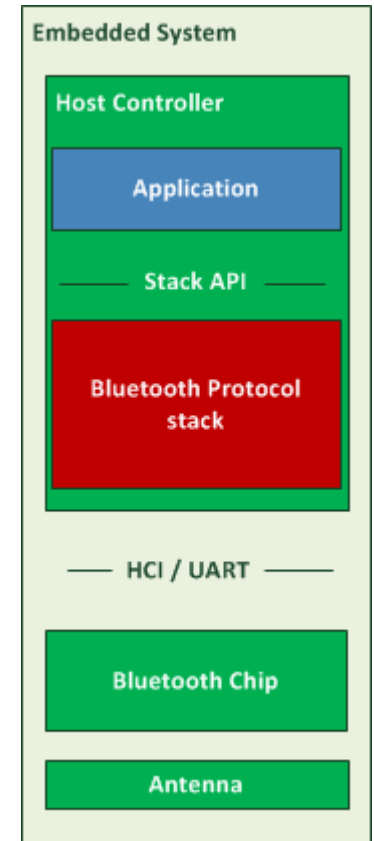
- Low-cost modules
- Bluetooth qualified
- Country-specific radio certifications available
- More complex functionality available

Disadvantages

- Integration of Bluetooth stack on host controller required
- Longer development time
- Additional Bluetooth qualification for system required
- Host controller needs to be powerful enough to carry Bluetooth stack and application

Chip Level Integration

The highest level of integration is the chip level integration, where the complete Bluetooth subsystem is integrated on the PCB of the host system.



Chip Level Integration

Integration steps

- Place and route Bluetooth components
- Route UART path
- Place and adapt antenna
- Route RF path (e.g. Balun)
- Port Bluetooth protocol stack to host controller system
- Implement use case using module control commands in host controller software
- Test and Certify

Chip Level Integration

Advantages

- Low BOM cost
- Low footprint
- Full functionality

Disadvantages

- Long development time, high NRE
- RF and Bluetooth know-how required
- No pre-certifications, pre-qualifications available

Summary

There is no general ideal way to integrate Bluetooth into Embedded Systems. The ideal way varies from product to product. Important factors that need to be taken into account are:

- Size
- Time
- Functionality
- BOM cost vs. development cost

Questions?

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