Enhancing Bluetooth Audio in Zephyr: Bringing Bluetooth Classic to the party

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Today’s talk

Quick recap of Bluetooth Classic

What we’ve done so far with Bluetooth Classic in Zephyr

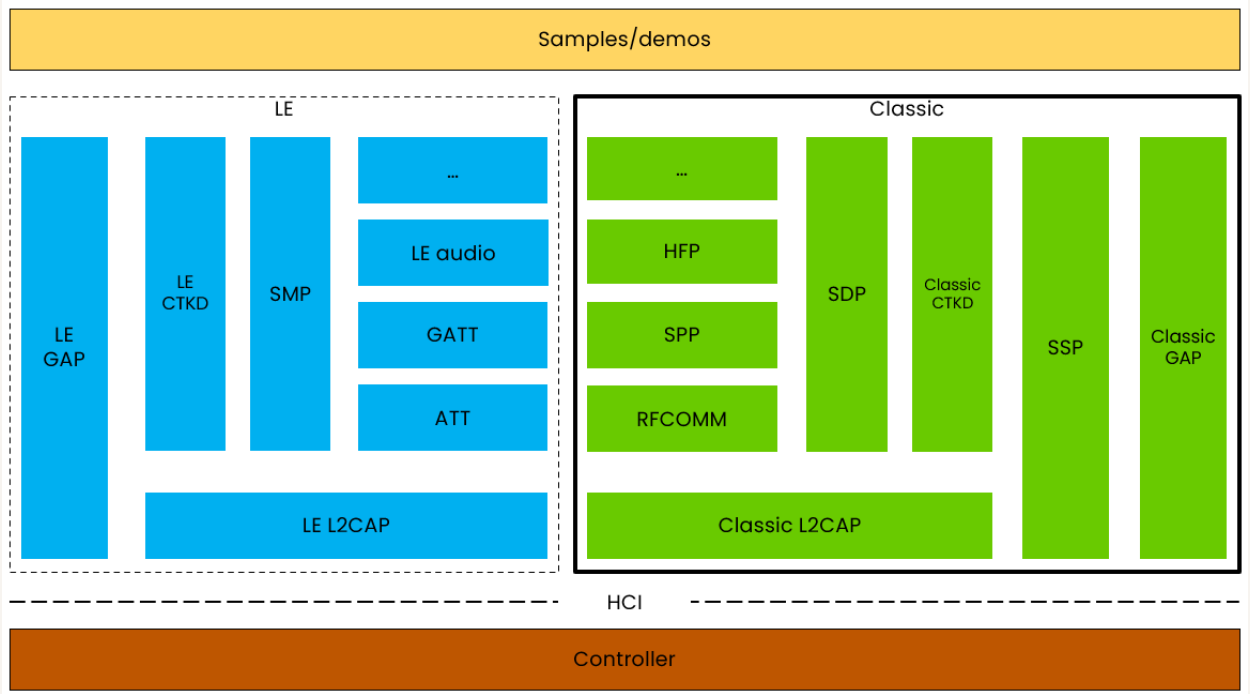
Future plans & where help is needed

Some Abbreviations and Acronyms being used in this talk

Acronym	Meaning
A2DP	Advanced Audio Streaming Profile (Bluetooth Classic audio)
Auto-PTS	Automated Profile Tuning Suite (Bluetooth testing framework)
PR	Pull Request (code change proposal)
CI/CV	Continuous Integration/Continuous Verification (automated testing)
MISRA	Motor Industry Software Reliability Association (coding guidelines)

What is Bluetooth Classic?

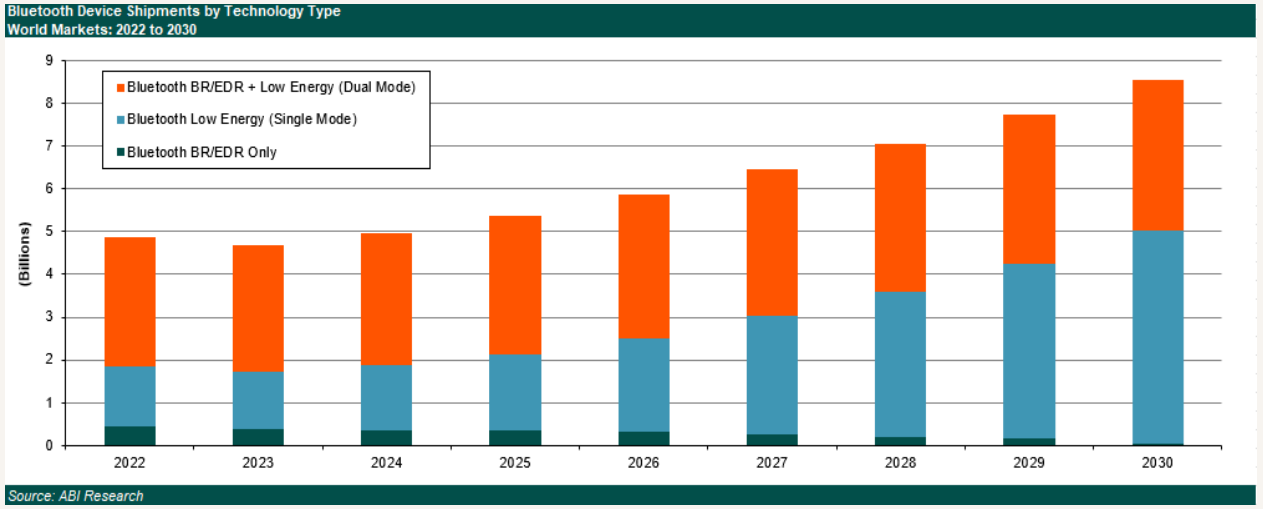
- Bluetooth Classic is the original Bluetooth technology introduced in the late 90’s for short range wireless communication
- Commonly used today for audio/voice applications in the modern-day phones, speakers, cars, gadgets and more
- Enables wireless music, calls, and data transfer in everyday devices



Bluetooth Classic and LE in the protocol stack

Why is Bluetooth Classic relevant today?

- Bluetooth Classic is gradually being replaced by Bluetooth Low Energy (LE)
    - LE is more energy-efficient, simplified, and gaining popularity
- This shift is ongoing, but manufacturers continuing to support Bluetooth LE Dual Mode (both Classic and LE) for the foreseeable future
    - Maintaining backward compatibility in new devices remains crucial
    - In case of audio, LE Audio ecosystem is still maturing across various OSes



Bluetooth Dual Mode shipments are expected to grow and be relevant for years to come

Bluetooth Classic Ecosystem in Zephyr

– NXP is the Maintainer

- Core stack implementation is completed
- Many audio and data profiles are available; more are coming
- Profile validation is ongoing (completed for core stack)
  - Auto-PTS & Functional test case including CI/CV enablement being added as part of validation process
- Community help is always welcome – test, review and contribute!
  - Expedite review for open PR's
  - Welcome contributions for Profiles, enabling more use cases

What's done, what's in progress

- **Core Stack:** L2CAP, GAP, SDP, SMP
- **Profiles complete:** RFCOMM, AVDTP, AVCTP, A2DP, HFP, GOEP
  - **In Progress:** AVRCP
  - **Planned:** PBAP, MAP, SPP, HID, OPP, FTP, BIP
- **Pull Request Stats:**
  - Submitted: 272 | Merged: 223 | In Review: 26 | Cancelled: 23

Bluetooth Classic Applications

- Classic audio (A2DP) is supported at the profile level, but end-end audio streaming is not yet available

- NXP has developed a simple sample app for end-to-end A2DP Source use case (to transmit a sine wave), upstreaming in progress

- Proposal: develop an end-to-end audio streaming sample app in Zephyr.
  - Helps to enable Zephyr adoption in many audio-based products

- We invite the Community to help support audio streaming apps for various audio use cases (e.g., A2DP Sink to receive audio stream) etc.

A few notes about Bluetooth LE Audio

- LE Audio is supported at the profile level
  … but no end-end audio streaming app is available today

- Proposals for LE Audio broader adoption and improvements:
  - Develop end-end sample app for LE Audio streaming use cases
  - Encourage community to perform interop testing with popular devices e.g., iphone, Samsung; submit relevant fixes

- NXP contributions so far
  - Functionality fixes to the Telephony Bearer Service (TBS) and Public Broadcast Profile (PBP) samples
  - Addressed interoperability issues with Pixel phones by submitting multiple fixes [1]
  - Plans to upstream samples for end-end audio streaming use cases

Bluetooth CI/CV coverage – suggested enhancements

- Goals
  - Use automated testing to ensure Bluetooth features work reliably
  - Make Zephyr Bluetooth safe and robust for automotive, industrial and consumer products

- Proposals
  - Implement MISRA compliance and static code analysis to support Zephyr stack adoption on automotive platforms, maintaining code quality and safety.
  - Extend CI/CV coverage to all auto-PTS tests including BLE Audio (long term)?
  - Enable twister framework to support testing with multiple boards - RFC
    - e.g. Supports testing central and peripheral roles on 2 boards
    - e.g. Supports testing MESH feature on multiple boards

- NXP Contributions so far
  - Integrated Bumble Google Opensource Bluetooth python stack into Zephyr CI/CV test framework [2]
  - Enabled more NXP boards(kw45, frdmw71, frdmw72, RT1060, RT1170)to Auto-PTS [3]
  - Enabled 90% of Auto-pts test cases on core and profiles to cover Bluetooth Classic in CI/CV [4]

Get in touch

- For questions on Bluetooth Classic sub-system and NXP’s role as maintainer, please reach out to Lyle Zhu from NXP

Thanks for your attention!

References in this deck

- [1] Interoperability issues found/fixed
  - https://github.com/zephyrproject-rtos/zephyr/pull/95994
  - https://github.com/zephyrproject-rtos/zephyr/pull/94526
  - https://github.com/zephyrproject-rtos/zephyr/pull/94520

- [2] Bumble integration
  - TestSuite

- [3] NXP board PRs
  - PR

- [4] Auto-PTS test cases
  - Test report

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