Implementing CoAP for Class 1 Devices

draft-kovatsch-lwig-class1-coap-00

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Class 1 Stack Configuration

Layer	Protocol
Application	CoAP
Transport	UDP
Network	IPv6 / RPL
Adaption	6LoWPAN
MAC	CSMA / link-layer bursts
Radio Duty Cycling	IEEE 802.15.4e / ContikiMAC / A-MAC
Physical	IEEE 802.15.4

MCUs
~ 100 KiB ROM
~ 10 KiB RAM

Experience from Erbium CoAP for Contiki

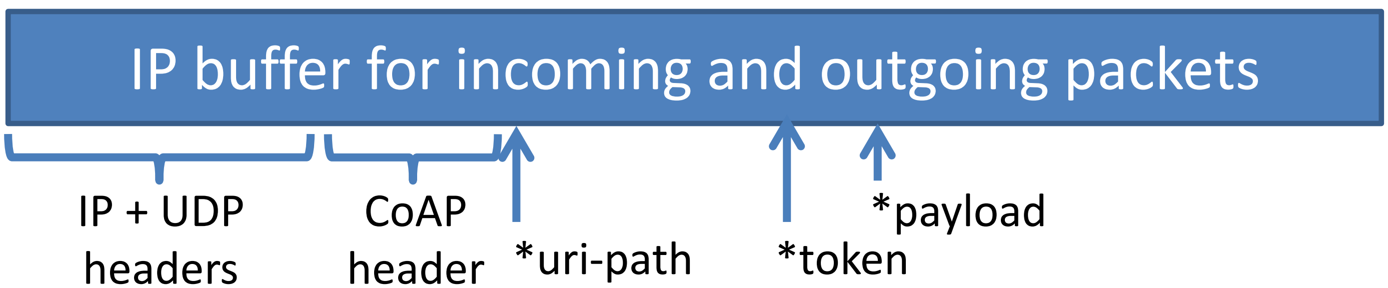
COAP IMPLEMENTATION

Memory Management

- Static
- Key parameters
  - Message buffer size (maximum message size)
  - Number of open transmissions
- Typical sizes
  - Messages with 128 or 256 bytes of payload
  - Often not even full MTU of 1280 bytes supported

Message Buffers

- Cooperative multi-threading
  - In-place processing



  - Strings point directly into IP buffer
  - Numerics parsed into variables (message struct)
  - Create reply directly in IP buffer? Good for ACKs

Separate Responses

- Required for long-lasting resource handlers
- Often done in split-phase execution, e.g.:
  - Activate sensor and wait for callback
  - Send UART command and wait for reply
- Provide API to avoid code duplication
  - automatically ACK request
  - store relevant information such as remote address
  - resume later to create response

Retransmissions

- Provide message buffers
  - Store serialized message for retransmissions
    - Requests do not change
    - CON Responses usually from long-lasting handler

  - Provide payload part as application buffer e.g., to serialize JSON
  - Problem: Maximum header size estimation

Observing

- Manage observe entries per resource
  - Saves space of resource handles in list
  - Store address, port, token, and last MID
- Provide one message buffer per obs. resource
  - Serialize message once and patch address + token
  - Store each retransmission state in observe entry
  - Easy to continue retransmissions with new state

Blockwise Transfers

- Expensive to provide buffer for whole transfer
  - Advantage of Blocks over IP fragments is that applications can make use of partial information
  - On-the-fly processing
  - Ordered blocks required at the receiver
- Main sender problem: s**o**nprintf()
  - How to slice a long string into blocks?
  - Resource-specific generator function good for RAM, but bad for ROM

Deduplication

- Generic filter with endpoint list is heavy
  - (40+2+2 + timestamp) times number of clients
- Aim for idempotent requests
- Do optimized filtering in resource handlers
  - Number of clients to manage potentially smaller
  - Can exploit application state for detection

Experience from wireless sensor networks and ubiquitous computing

LOW POWER WIRELESS

Radio Duty Cycling

- Implemented in independent layer
- Virtually always-on
- Trades energy for latency
- Example: ContikiMAC
  - Server-initiated protocol
  - 0.3% idle duty cycle at 4 Hz channel checks
- Well-suited for IEEE 802.15.4

Sleepy Nodes

- Impact on application layer
  - [I-D.vial-core-mirror-proxy]
  - [I-D.fossati-core-publish-option]
  - [I-D.rahman-core-sleepy]
- Useful for other physical layers
  - Single hop
  - Long network association times
  - Example: low-power Wi-Fi
- Useful for energy harvesting