XFS4IoT SP-Dev Workgroup

5 October 2021

XFS4IoT Workgroup Progress

- Framework for 4 devices available
  - Card Reader (released May 2021)
  - Cash Dispenser (July 2021), with full end-to-to security to follow
  - Text Terminal Unit (July 2021)
  - EPP Key Management and Crypto classes (Sept 2021) with Keyboard and PinPad classes to follow
- C# and C++ sample code released, demos on YouTube

XFS4IoT Workgroup Progress

- Framework code is available to:
  - Implement XFS4 SPs
  - Review, test with our samples
  - Write test tools
- Framework code updated regularly

Pinpad and Keyboard classes release

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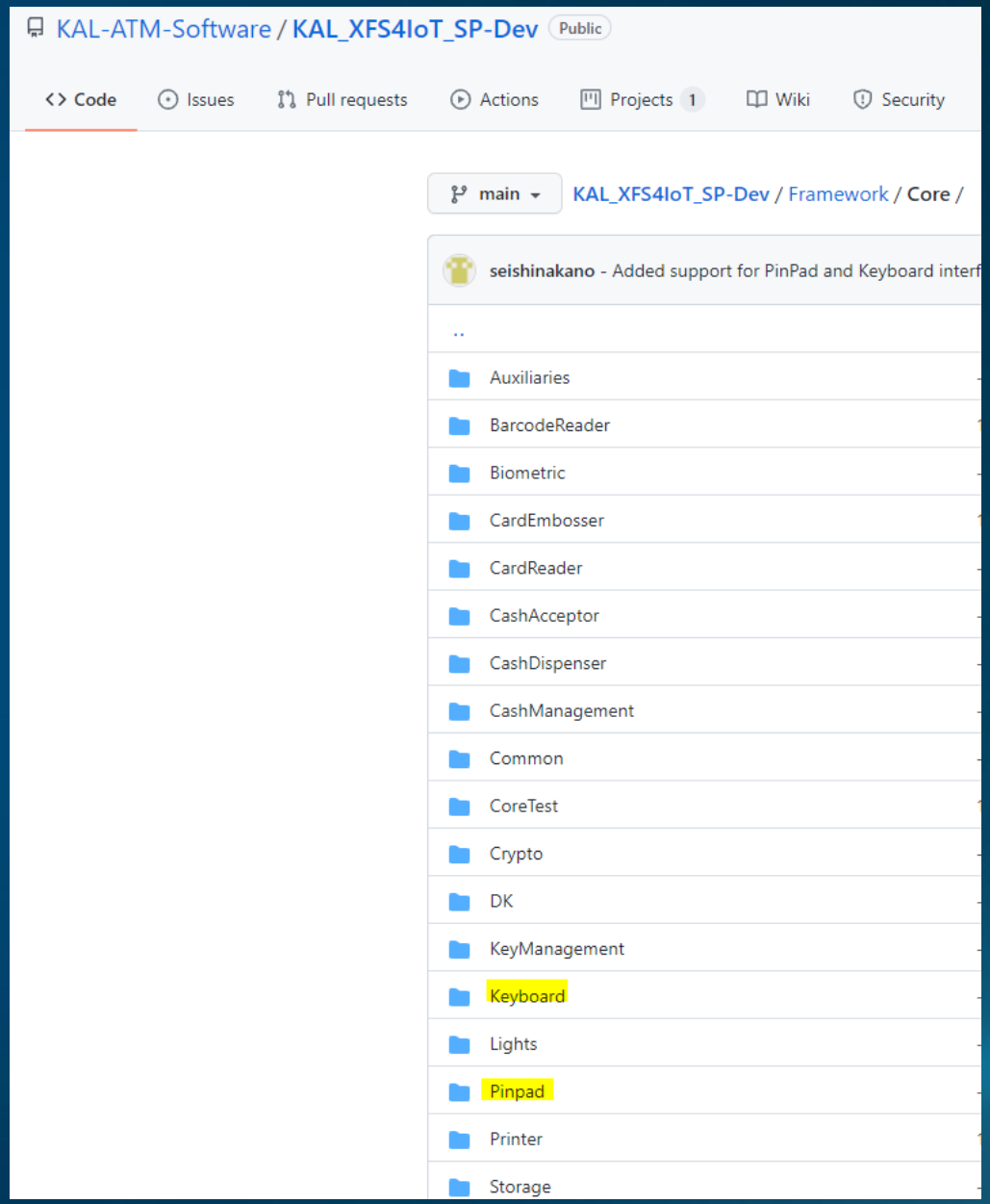
Pinpad & Keyboard support

- Pinpad and Keyboard classes now available



Pinpad & Keyboard support

- Details of the changes in the following commit

KAL-ATM-Software / KAL_XFS4IoT_SP-Dev Public

Code | Issues | Pull requests | Actions | Projects 1 | Wiki | Security | Insights | Settings

History for KAL_XFS4IoT_SP-Dev / Framework

Commits on Oct 4, 2021

- Added support for PinPad and Keyboard interfaces framework. ...

seishinakano committed 20 hours ago

KAL-ATM-Software / KAL_XFS4IoT_SP-Dev Public

Code | Issues | Pull requests | Actions | Projects 1 | Wiki | Security | Insights | Settings

- Added support for PinPad and Keyboard interfaces framework.

```
- Updated TextTerminal framework to the latest specification published on the September preview.
- Cancel command supported in the framework.
```

main

v0.0.4-alpha.1

Pinpad & Keyboard support

- Sample also available

KAL-ATM-Software / KAL_XFS4IoT_SP-Dev-Samples Public

Code | Issues 2 | Pull requests | Actions | Projects | Wiki | Security

main | KAL_XFS4IoT_SP-Dev-Samples / Devices /

seishinakano Changed to use E2E public package for C++ CLI

..

SampleCardReader

SampleCashDispenser

SampleEncryptor

SamplePinPad

SampleServerHost

TextTerminalSample

SPs.sln

Pinpad & Keyboard support

- Latest pre-release v.0.0.4-alpha1 for NuGet packages

KAL.XFS4IoT.SP-Dev.Framework.CardReader.0.0.4-alpha.1.nupkg
KAL.XFS4IoT.SP-Dev.Framework.CardReader.0.0.4-alpha.1.snupkg
KAL.XFS4IoT.SP-Dev.Framework.CashDispenser.0.0.4-alpha.1.nupkg
KAL.XFS4IoT.SP-Dev.Framework.CashDispenser.0.0.4-alpha.1.snupkg
KAL.XFS4IoT.SP-Dev.Framework.CashManagement.0.0.4-alpha.1.nupkg
KAL.XFS4IoT.SP-Dev.Framework.CashManagement.0.0.4-alpha.1.snupkg
KAL.XFS4IoT.SP-Dev.Framework.Common.0.0.4-alpha.1.nupkg
KAL.XFS4IoT.SP-Dev.Framework.Common.0.0.4-alpha.1.snupkg
KAL.XFS4IoT.SP-Dev.Framework.Core.0.0.4-alpha.1.nupkg
KAL.XFS4IoT.SP-Dev.Framework.Core.0.0.4-alpha.1.snupkg
KAL.XFS4IoT.SP-Dev.Framework.Crypto.0.0.4-alpha.1.nupkg
KAL.XFS4IoT.SP-Dev.Framework.Crypto.0.0.4-alpha.1.snupkg
KAL.XFS4IoT.SP-Dev.Framework.Keyboard.0.0.4-alpha.1.nupkg
KAL.XFS4IoT.SP-Dev.Framework.Keyboard.0.0.4-alpha.1.snupkg
KAL.XFS4IoT.SP-Dev.Framework.KeyManagement.0.0.4-alpha.1.nupkg
KAL.XFS4IoT.SP-Dev.Framework.KeyManagement.0.0.4-alpha.1.snupkg
KAL.XFS4IoT.SP-Dev.Framework.Native.EndToEnd.0.0.4-alpha.1.nupkg
KAL.XFS4IoT.SP-Dev.Framework.PinPad.0.0.4-alpha.1.nupkg
KAL.XFS4IoT.SP-Dev.Framework.PinPad.0.0.4-alpha.1.snupkg
KAL.XFS4IoT.SP-Dev.Framework.Server.0.0.4-alpha.1.nupkg
KAL.XFS4IoT.SP-Dev.Framework.Server.0.0.4-alpha.1.snupkg
KAL.XFS4IoT.SP-Dev.Framework.ServiceInterfaces.0.0.4-alpha.1.nupkg
KAL.XFS4IoT.SP-Dev.Framework.ServiceInterfaces.0.0.4-alpha.1.snupkg
KAL.XFS4IoT.SP-Dev.Framework.TextTerminal.0.0.4-alpha.1.nupkg
KAL.XFS4IoT.SP-Dev.Framework.TextTerminal.0.0.4-alpha.1.snupkg

Already supported by KeyManagement and Crypto

- Remote Key Loading with TR34 supported
- Other types of RKL are also fully supported (signature-based, E-RKL…)
- Key Exchange with TR31 supported
- Enabling E2E security feature
- Any device can support Key Management – just requires an HSE

Latest functions supported

- Status and Capabilities
- Data entry
- Pin entry and format Pin
- Secure key entry
- Initialise, load and import key methods
- Get key names and KCV (Key Check Value)

Demo with real EPP

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Demo with real EPP

Demo video will be available on YouTube.

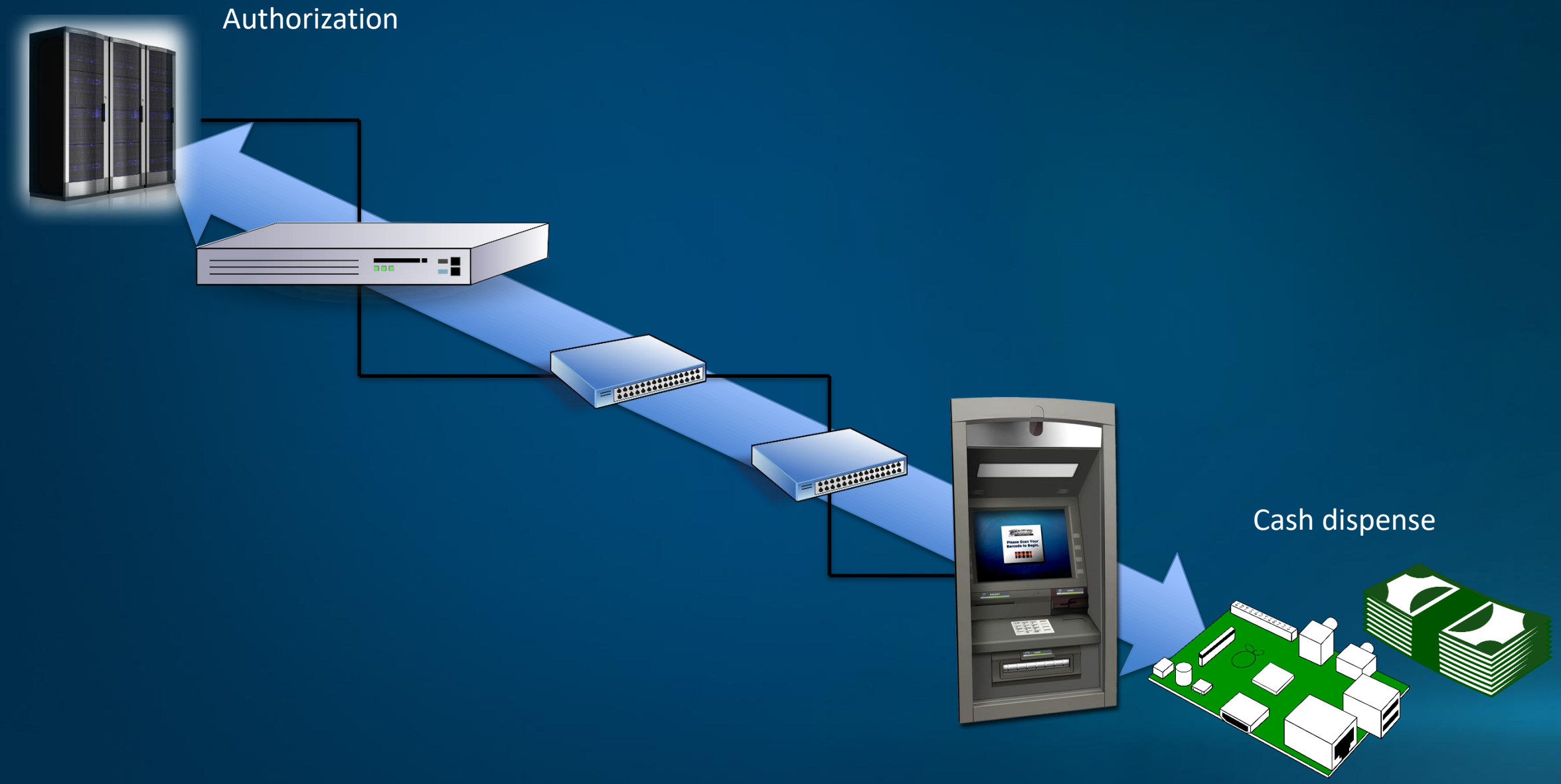
All previous demo videos can be found on the KAL ATM Software YouTube channel:

https://www.youtube.com/user/ATMsoftware/videos

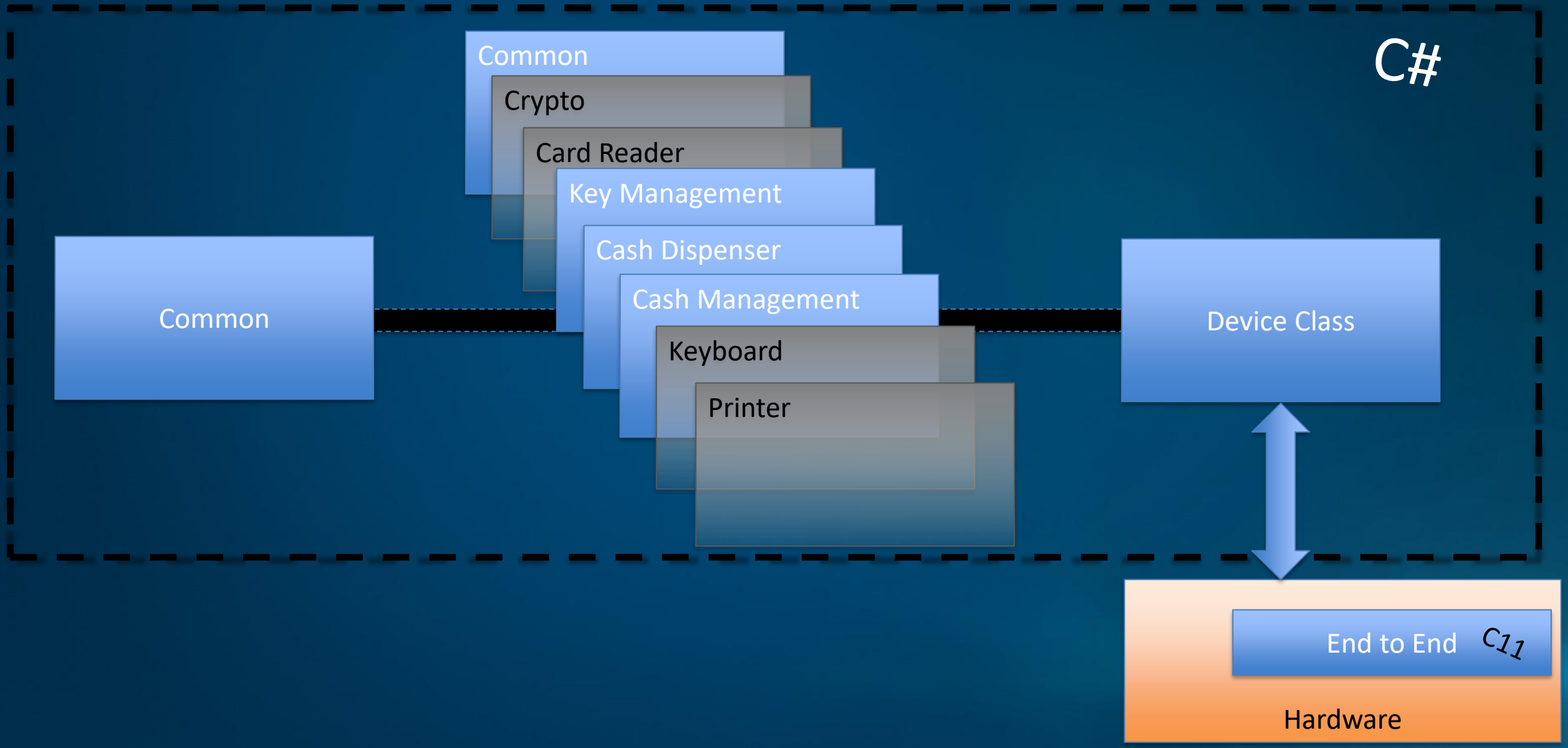
XFS4IoT SP-Dev E2E support

First draft E2E support

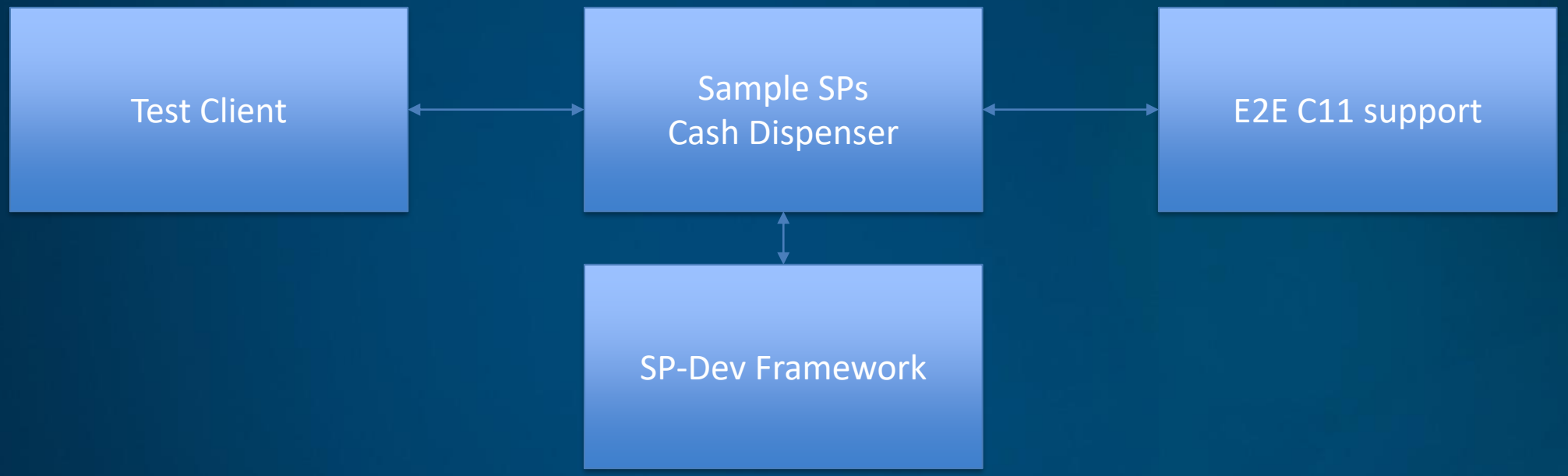
E2E security



Framework with end to end security



Components



TestClient example

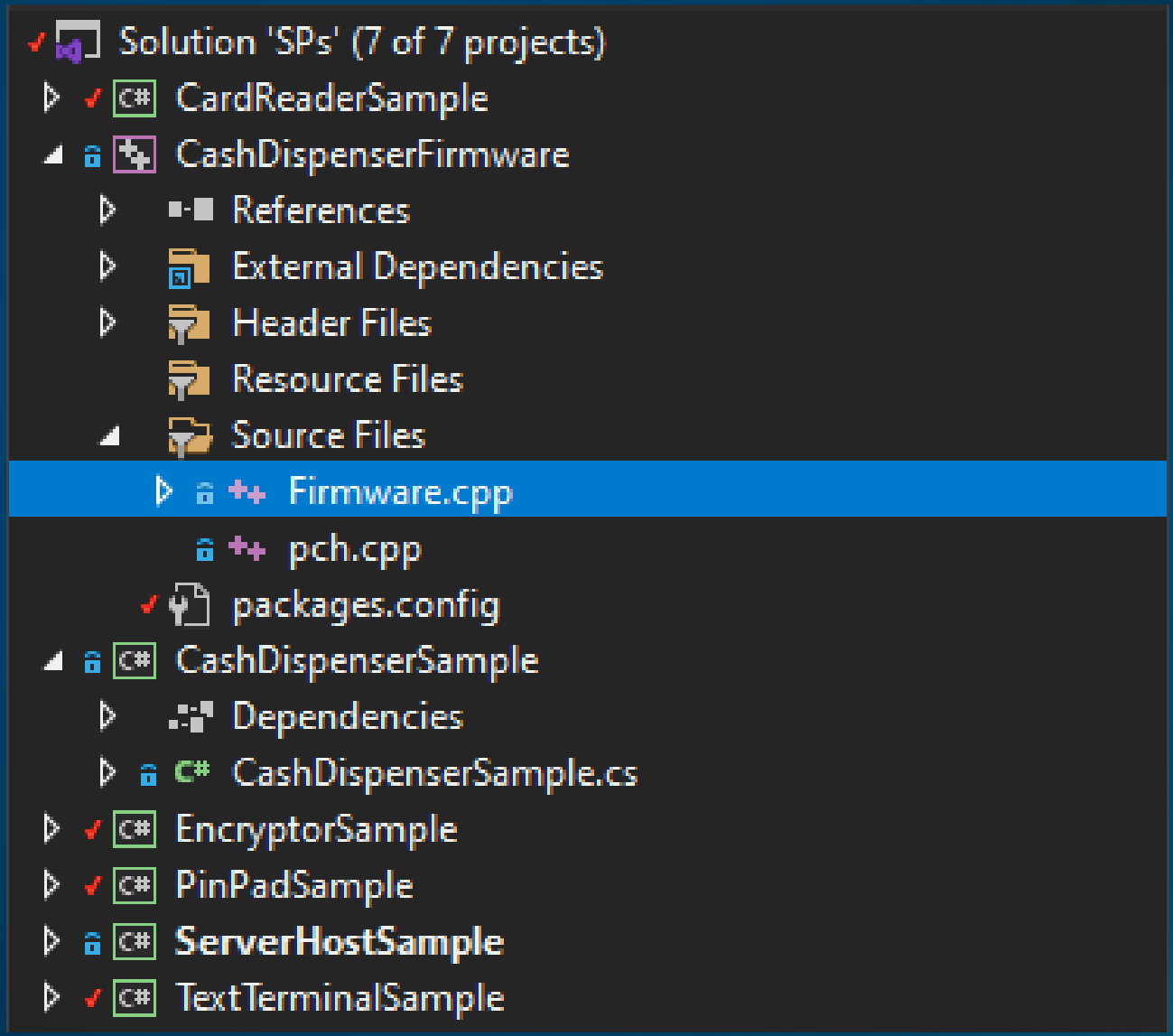
```
5 references | Kit Patterson, 2 hours ago | 1 author, 3 changes
private async Task<string> DoGetCommandNonce()
{
    var command = new GetCommandNonceCommand(RequestId.NewID(),
                                             Payload: new(Timeout: 10_000)
                                             );

    await cashDispenser.SendCommandAsync(command);
    var response = await GetCompletionAsync<GetCommandNonceCompletion>(cashDispenser);
    if (response.Payload.CompletionCode ≠ XFS4IoT.Completions.MessagePayload.CompletionCodeEnum.Success)
        throw new Exception($"GetCommandNonce failed: {response.Payload.CompletionCode}");

    return response.Payload.CommandNonce;
}

7 references | Kit Patterson, 3 days ago | 1 author, 2 changes
private async Task DoDispenseCash(int Amount, string CurrencyID, string Token)
{
    var command = new DispenseCommand(RequestId.NewID(),
                        Payload: new(Timeout: 10_000,
                                     Denomination: new(Currencies: new() { { CurrencyID, Amount } } ),
                                     MixNumber:1,
                                     Token: Token
                                     )
                        );

    await cashDispenser.SendCommandAsync(command);
    var response = await GetCompletionAsync<DispenseCompletion>(cashDispenser);
    if (response.Payload.CompletionCode ≠ XFS4IoT.Completions.MessagePayload.CompletionCodeEnum.Success)
        Logger.LogWarning($"Dispense failed: {response.Payload.CompletionCode}");

}
```

TestClient example

```
4 references | Kit Patterson, 21 hours ago | 1 author, 1 change
private static string MakeToken(string nonce, bool valid)
{
    // 'valid' or invalid HMAC.
    var HMAC = valid ? "CB735612FD6141213C2827FB5A6A4F4846D7A7347B15434916FEA6AC16F3D2F2"
                     : "CB735612FD6141213C2827FB5A6A4F4846D7A7347B15434916FEA6AC16F3D2F3";

    var tokenBuilder = new System.Text.StringBuilder($"NONCE={nonce},TOKENFORMAT=1,TOKENLENGTH=$$$$,ANOTHERKEY=12345,HMACSHA256={HMAC}");

    // The token length field is fix at four digits to make it easy to calculate.
    // Inject this into the string.
    var len = $"{tokenBuilder.Length:X4}";
    tokenBuilder = tokenBuilder.Replace("$$$$", len);

    string token = tokenBuilder.ToString();
    return token;
}
```

Don’t do this!!!

Sample service



Sample cash dispenser

```
0 references | Kit Patterson, 21 hours ago | 2 authors, 5 changes
public async Task<DispenseResult> DispenseAsync(IDispenseEvents events, DispenseRequest dispenseInfo, Cancellatior
{
    if (dispenseInfo.E2EToken is null)
        return new DispenseResult(MessagePayload.CompletionCodeEnum.InvalidToken, dispenseInfo.Values, LastDispens

    if ( !Firmware.VerifyAndDispense(dispenseInfo.E2EToken) )
    {
        return new DispenseResult(MessagePayload.CompletionCodeEnum.InvalidToken, dispenseInfo.Values, LastDispens
    }
```

Sample ‘firmware’

```
bool KAL::XFS4IoTSP::CashDispenser::Sample::Firmware::VerifyAndDispense(System::String^ Token)
{
    // Convert the .net UTF16 string into a native UTF8 string.
    pin_ptr<const wchar_t> pinnedToken = PtrToStringChars(Token);
    wstring wideToken = pinnedToken;

    wstring_convert<codecvt_utf8<wchar_t>> utf8Converter;
    string utf8Token;
    try
    {
        utf8Token = utf8Converter.to_bytes(wideToken);
    }
    catch (range_error const &)
    {
        cout << "Error: Invalid token. Conversion to UTF8 failed after " << dec << utf8Token.size() << " characters:\n";
        for (auto c : utf8Token)
            cout << hex << showbase << c << '\n';
    }

    // Check that the token is valid.
    // Include null in token (buffer) size.
    auto tokenValid = ValidateToken(utf8Token.c_str(), utf8Token.size()+1);
    if (!tokenValid)
        return false;

    return true;
}

System::String^ KAL::XFS4IoTSP::CashDispenser::Sample::Firmware::GetCommandNonce() { ... }

void KAL::XFS4IoTSP::CashDispenser::Sample::Firmware::ClearCommandNonce() { ... }
```

Core firmware check

```
/// <summary>
/// Validate that a token has a valid format.
/// </summary>
/// <description>
/// Takes a token string and reports if it is valid or not. If the token is valid then it is safe
/// to proceed with the operation protected by the token. If not, the operation should fail with an
/// error.
/// The token still is assumed to be unsafe and may have been passed by an attacker. Everything
/// possible will be done to avoid invalid behaviour due to a hostile token.
/// </description>
///
/// <param name="Token">Null terminated token string</param>
/// <param name="TokenSize">Token buffer size, including null</param>
/// <returns>true or false</returns>
bool ValidateToken(char const* const Token, size_t TokenSize)
{
    LogV("ValidateToken( Token=\"%.1024s\", TokenSize=%d )", Token, TokenSize);

    // Parameter checking.
    // Consider the token to be an untrusted value, so maximum validity checking.
    // Null token
    if (Token == NULL)
    {
        Log("ValidateToken: Null token ⇒ false");
        return false;
    }

    size_t TokenStringLength = strlen(Token) + 1;       // Plus null
    // Zero length string.
    if (TokenStringLength == 1)
    {
        Log("ValidateToken: Empty token ⇒ false");
        return false;
    }
    // Buffer length and string size don't match
    if (TokenStringLength ≠ TokenSize)
    {
        Log("ValidateToken: TokenSize didn't match token length ⇒ false");
        return false;
    }
```

Firmware functions to implement

```
/// ...
extern C_LINKAGE void NewNonce( char const ** Nonce );

/// ...
extern C_LINKAGE bool CompareNonce(char const* const CommandNonce, size_t NonceLength);

/// ...
extern C_LINKAGE void ClearNonce();

/// ...
extern C_LINKAGE bool CheckHMAC(char const *const Token, unsigned int TokenLength, unsigned char const* const TokenHMAC);

/// ...
extern C_LINKAGE void FatalError(char const* const Message);

/// ...
extern C_LINKAGE void Log(char const* const Message);
```

Test client

```
04:50:34.2882 (00:00:20.8046100):  25:GetCommandNonceCommand
04:50:34.2898 (00:00:20.8061785):  25:Acknowledge
04:50:34.2906 (00:00:20.8070408):  25:GetCommandNonceCompletion
04:50:34.2919 (00:00:20.8083508): Nonce : 2
04:50:34.2924 (00:00:20.8088389): Dispense (valid token)
04:50:34.2932 (00:00:20.8095898): Token: NONCE=2,TOKENFORMAT=1,TOKENLENGTH=0083,ANOTHERKEY=12345,HMACSHA256=CB735612FD6141213C2827F
B5A6A4F4846D7A7347B15434916FEA6AC16F3D2F2
04:50:34.3160 (00:00:20.8323777):  26:DispenseCommand
04:50:34.3439 (00:00:20.8603445):  26:Acknowledge
04:50:35.4792 (00:00:21.9956534):  26:DispenseCompletion
04:50:35.4868 (00:00:22.0032205):  27:PresentCommand
04:50:35.5002 (00:00:22.0166561):  27:Acknowledge
04:50:36.5835 (00:00:23.0999570):  27:PresentCompletion
04:50:36.5842 (00:00:23.1006132): Dispense (Stale token)
04:50:36.5846 (00:00:23.1010338): Token: NONCE=2,TOKENFORMAT=1,TOKENLENGTH=0083,ANOTHERKEY=12345,HMACSHA256=CB735612FD6141213C2827F
B5A6A4F4846D7A7347B15434916FEA6AC16F3D2F2
04:50:36.5853 (00:00:23.1017263):  28:DispenseCommand
04:50:36.5880 (00:00:23.1044479):  28:Acknowledge
04:50:37.6065 (00:00:24.1229289):  28:DispenseCompletion
04:50:37.6085 (00:00:24.1249283): Dispense (Invalid HMAC)
04:50:37.6095 (00:00:24.1259153): Invalid HMAC: NONCE=2,TOKENFORMAT=1,TOKENLENGTH=0083,ANOTHERKEY=12345,HMACSHA256=CB735612FD614121
3C2827FB5A6A4F4846D7A7347B15434916FEA6AC16F3D2F3
04:50:37.6109 (00:00:24.1273395):  29:DispenseCommand
04:50:37.6171 (00:00:24.1335197):  29:Acknowledge
04:50:37.6231 (00:00:24.1395400):  29:DispenseCompletion
04:50:37.6246 (00:00:24.1410308): Dispense failed: InvalidToken
04:50:37.6255 (00:00:24.1419278): Dispense (Invalid nonce)
04:50:37.6264 (00:00:24.1427922): Invalid nonce: NONCE=FFFF,TOKENFORMAT=1,TOKENLENGTH=0086,ANOTHERKEY=12345,HMACSHA256=CB735612FD61
41213C2827FB5A6A4F4846D7A7347B15434916FEA6AC16F3D2F2
04:50:37.6272 (00:00:24.1436531):  30:DispenseCommand
04:50:37.6305 (00:00:24.1469156):  30:Acknowledge
04:50:37.6341 (00:00:24.1505328):  30:DispenseCompletion
04:50:37.6356 (00:00:24.1519863): Dispense failed: InvalidToken
04:50:37.6359 (00:00:24.1523171): Done
```

Status

- Complete
  - Added firmware C library support (including unit tests.)
  - Framework support for Common.GetCommandNonce, Common.ClearCommandNonce, and CashDispenser.Dispense token commands.
  - Sample SP implementation using ‘firmware’ code and dispenser implementation
  - (Command line) test client showing dispense and present sequence

To do

- Read and track token keys – such as dispense amount
- Enforce dispense values
- Present should delete the nonce/invalidate tokens
- Support for generating response tokens
- GetPresentStatus token support
- UI test client

Not included

- Key handling – KeyManagement, but needs hardware support
- Cryptography – Must be done in hardware
- Random number or persistent storage – needs to be done in hardware

XFS4 Specification: roadmap update and September preview

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XFS4IoT specification

- September preview published
- Online version and downloaded PDF available (link)

XFS4IoT specification

- Roadmap:
  - October:
    - Code freeze
    - Document generation
    - Final review period by CEN committee members
  - Mid-December:
    - Final validation
    - Release process with CEN / Preview updated

XFS4IoT specification : Latest updates

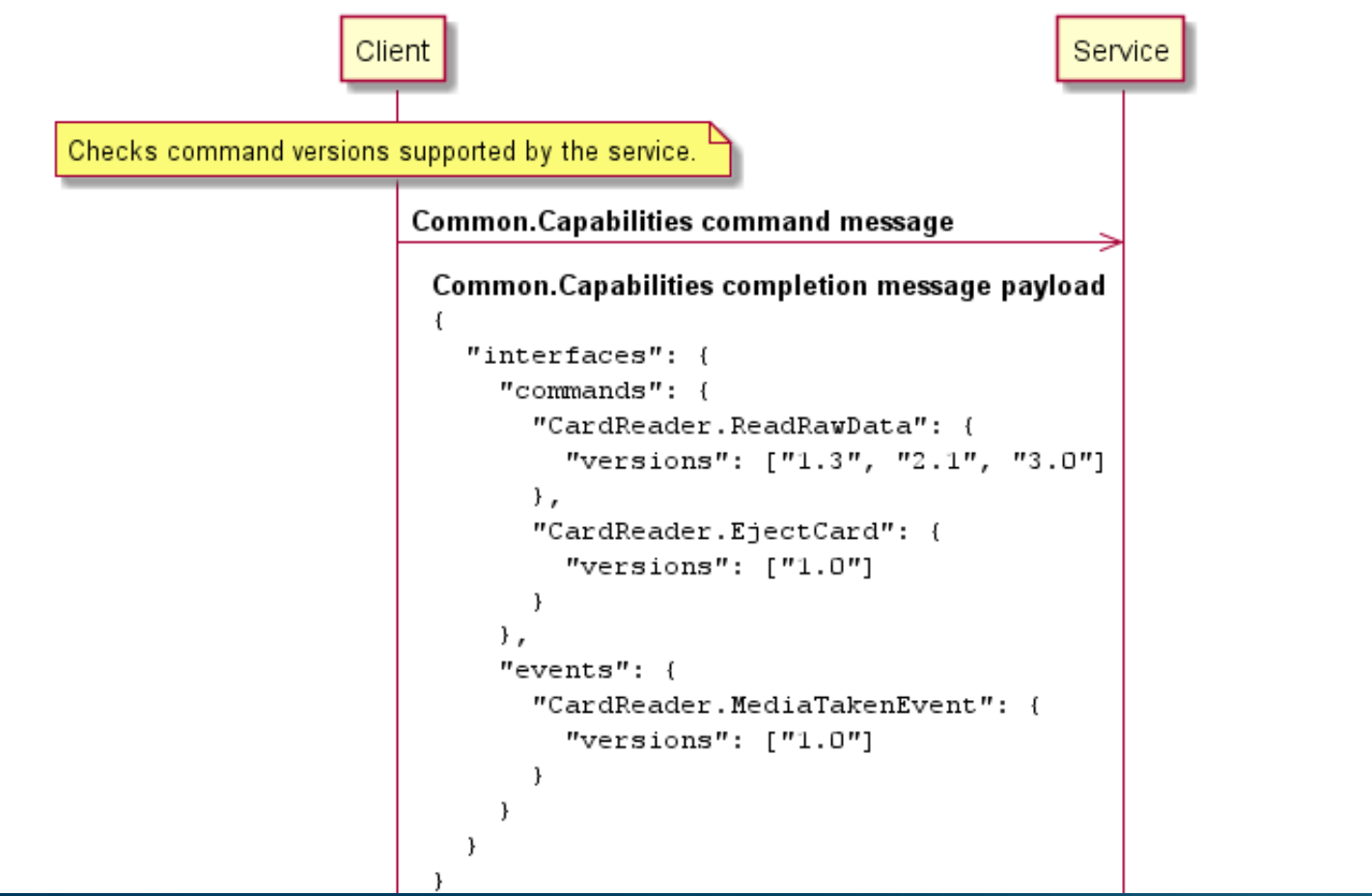
- New card reader interface:
  - Dispensing capabilities
  - New “Move” command
- New Storage Interface
  - To be used with other device interfaces which requires storage
  - Bins and cash unit storage handling

XFS4IoT specification : Latest updates

- Service discovery own interface:
  - Move out of Common
- New Lights and Auxiliaries interfaces
  - Doors
  - Alarm
  - Generic sensors…

XFS4IoT specification : Latest updates

- Versioning information
  - Capabilities command
  - Per command
  - Per event



What’s next?

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What's next?

- Updating the current framework with the latest specification changes from the September preview
- Support more classes:
  - Printer
  - Vendor Mode/Vendor Application
  - Auxiliaries

→ *Everything we need to support a complete Cash Out ATM…*

What’s next?

- Full E2E process on real hardware
- Proof of concept on small devices using a TPM chip as HSE
- Support workgroup members with implementation using the framework
- Guest speakers

Next call

MS Teams

- First Tuesday of each month at 1300 UK time

Next call: 2nd November 2021, 1300 UK, 0900 US EST, 2200 Tokyo time

(Note: **US** changes clocks on the 7th November, so the call will be back to the 0800 EST slot for the US from December).