Zephyr™ Project Security

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Security Researcher

Overview

- About Me
- Intro to Zephyr
- What We're Trying To Protect From
- Secure Development Lifecycle
- TinyCrypt
- Possible Future Directions

About Me

- **Constanza Heath, Security Researcher, Intel Open Source Technology Center**
- 1998 Time Warner Cable's Information Technology Dept.
- 2003 Raytheon's Vision Systems, Remote Satellite, and Electronic Warfare divisions.
- 2004 Hewlett Packard's Imaging Product Group, All-in-One Division, and Photosmart Printer Division.
- Joined Intel in 2010.
- Previously worked on Moblin, MeeGo and Tizen operating systems.
- Career up and down the software stack, making security a natural discipline.
- Design core security features, review architctures, and implement secure software solutions.
- Currently focused on IoT security and enablement and Cloud OSs.

What is Zephyr?

- Microcontroller operating system
- Very small memory footprint (will run in 8k)
- Open Source under Apache* 2.0 license, hosted by Linux* Foundation
- Supports multiple architectures

Why Zephyr Project?

Strategic Investment

Best-of-Breed RTOS

True Open Source

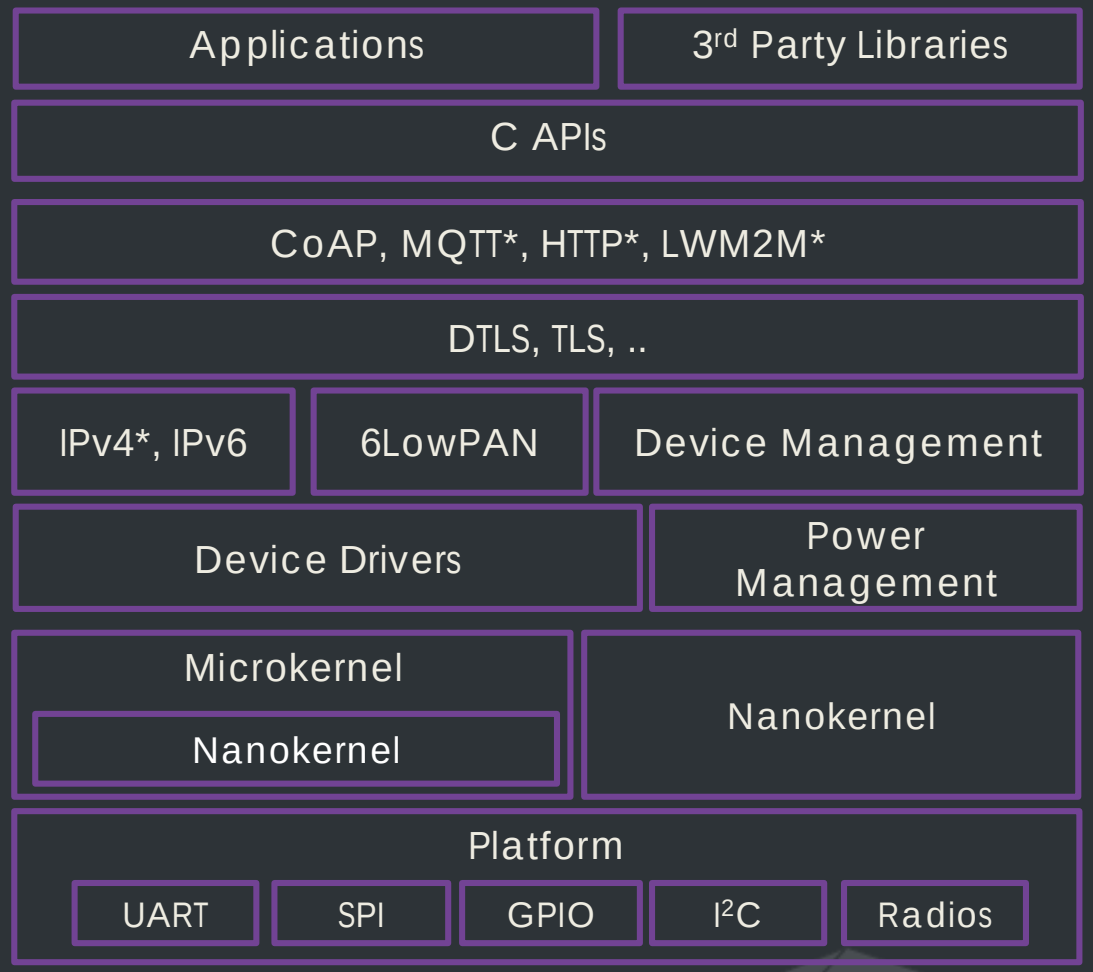
Permissively Licensed

Established Code Base

Secure

Zephyr Overview

- Provide an OS that runs best on MCUs for wearable and IoT devices, where the cost of the silicon is minimal
- Highly Configurable, Highly Modular
- Kernel mode only
- Two Modes:
  - Nanokernel: Limited functionality targeting small footprint (below 10k)
  - Microkernel (superset of nanokernel): with additional functionality and features
- No user-space and no dynamic runtimes
- Memory and Resources are typically statically allocated
- Cross architecture (IA32, ARM*, ARC, others under discussion)



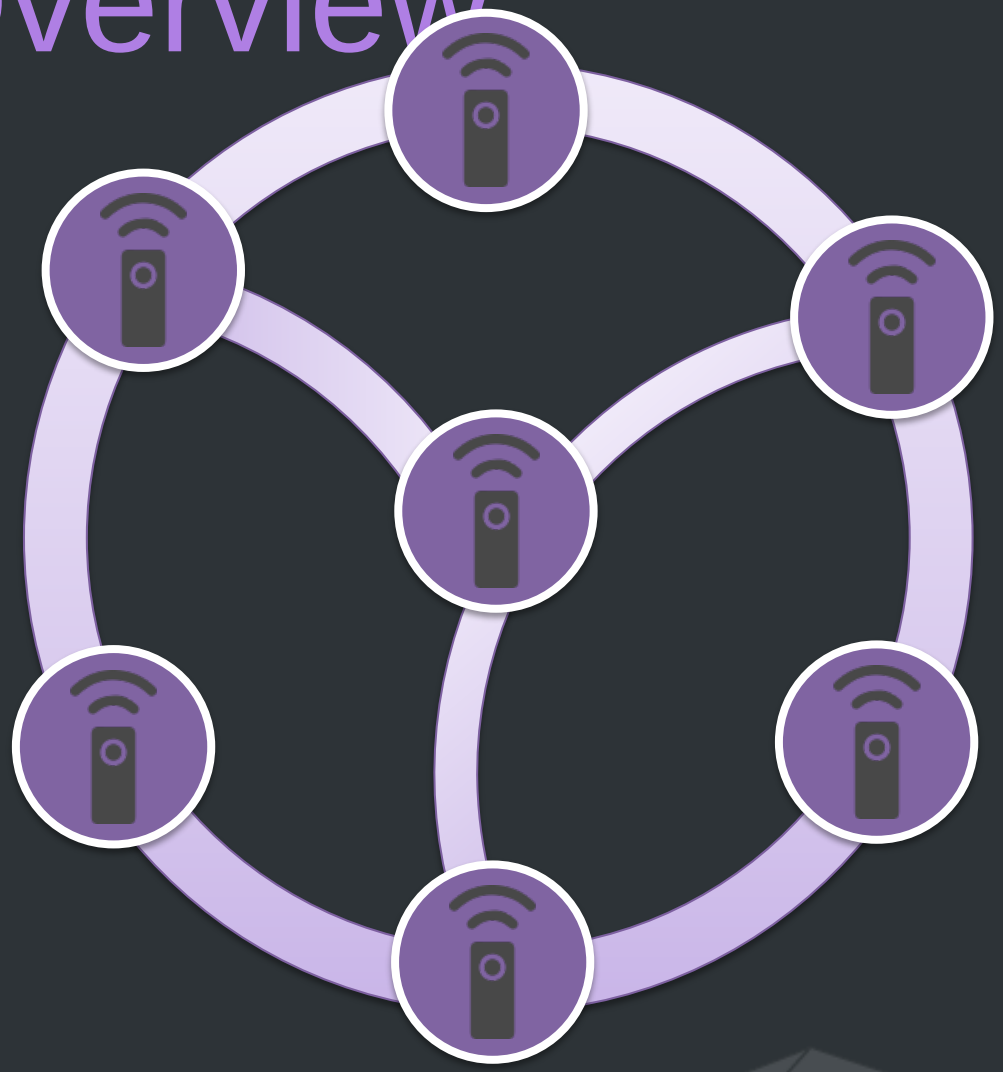
* planned

Zephyr Nanokernel Overview

- A high-performance, multi-threaded execution environment with a basic set of kernel features
- Ideal for systems with sparse memory (the kernel itself requires as little as 2 KB!) or only simple multi-threading requirements (such as a set of interrupt handlers and a single background task)
- Examples of such systems include:
  - embedded sensor hubs
  - environmental sensors
  - simple LED wearables
  - store inventory tags

Zephyr Microkernel Overview

- Supplements the capabilities of the nanokernel to provide a richer set of kernel features
- Suitable for systems with
  - heftier memory (50 to 900 KB)
  - multiple communication devices (like Wi-Fi and Bluetooth® Low Energy)
  - and multiple data processing tasks
- Examples of such systems include:
  - Fitness wearables
  - Smart watches
  - IoT wireless gateways



Supported Platforms

Arduino* 101

Intel® Quark™ D2000 CRB

2nd Generation Intel® Galileo

FRDM-K64F

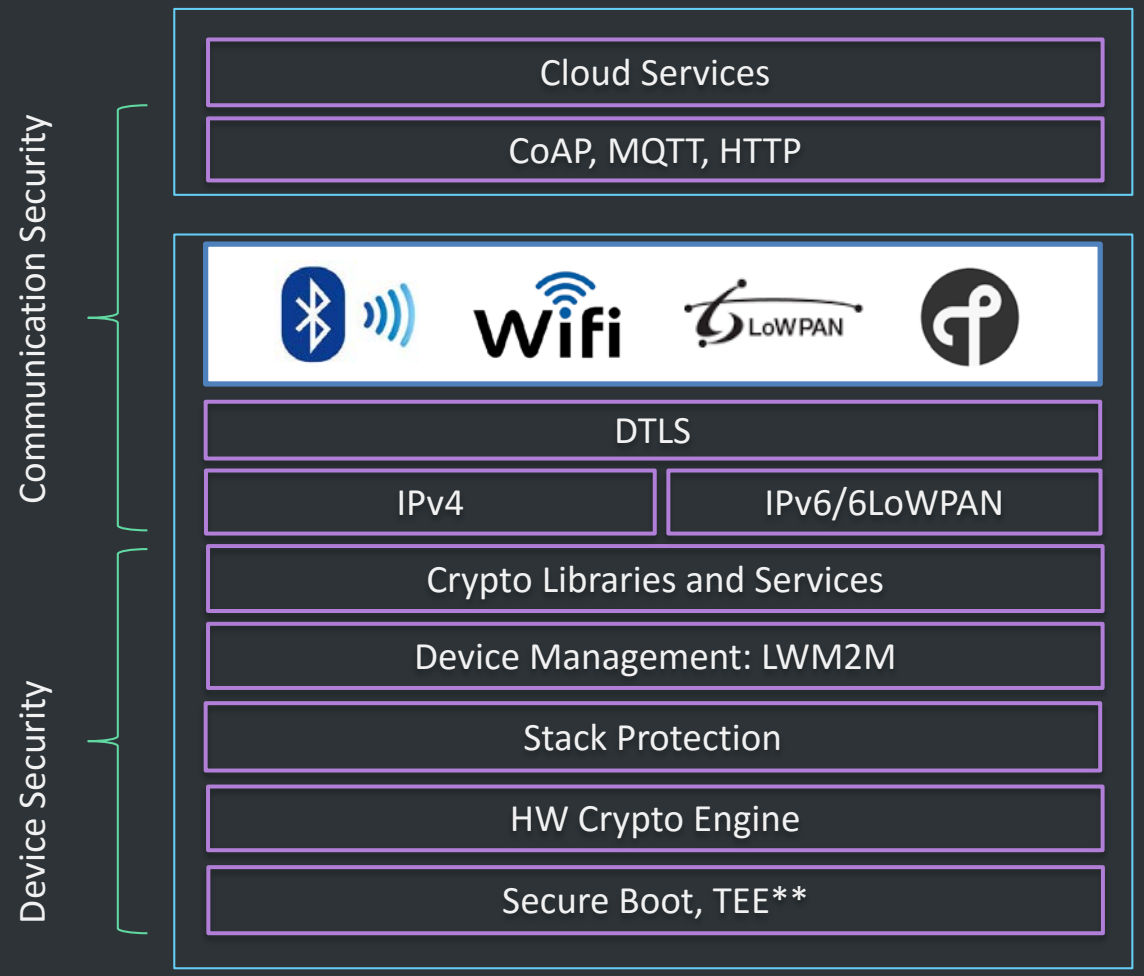
Arduino Due

► More platforms and boards to follow ◄

Anas Nashif - Zephyr™ Project Overview Tuesday, April 5, 2016

Security

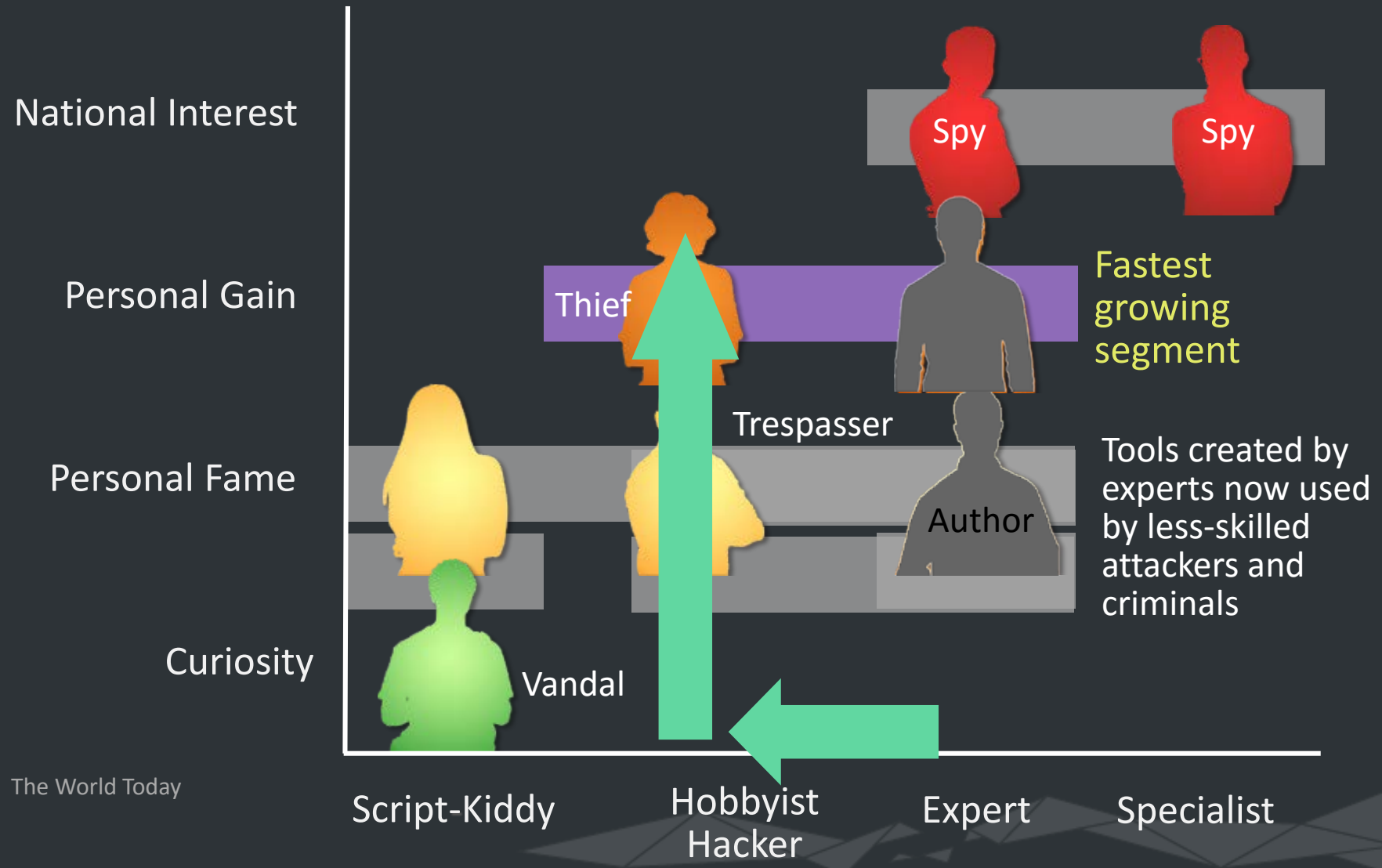
- Standardized building block and robust communication stacks
- Cryptographic library based on TinyCrypt
- Static and single binary applications, Single address space, No loadable modules
- Planned security features:
  - Device Management and Updates
  - APIs to support vendor specific Crypto implementations (SW/HW)
  - Secure Key Storage



What’s Out There?

Not Your Mother’s Hacker

Security Hackers Ecosystem



The World Today

”Two newly-discovered flaws light fire under IoT security” -ZDNet

“’Internet of Things’ security is hilariously broken and getting worse” –Ars Technica

Tentler has discussed the lack of security on webcams and other devices connected to the Internet at multiple conferences, and occasionally he posts interesting results from Shodan to his Twitter feed. The popularity of the devices and their lack of security is creating a burgeoning problem, he said in an e-mail interview.

“It says neither consumers nor vendors care about security, and it’s going to be an amazing apocalypse,” Tentler said.

”Princeton researches fin[illegible]security flaws in IoT devices” - Engadget

”Internet of Things Security Problem Just Keeps Getting Bigger” -eWeek

Just in the last few Months!

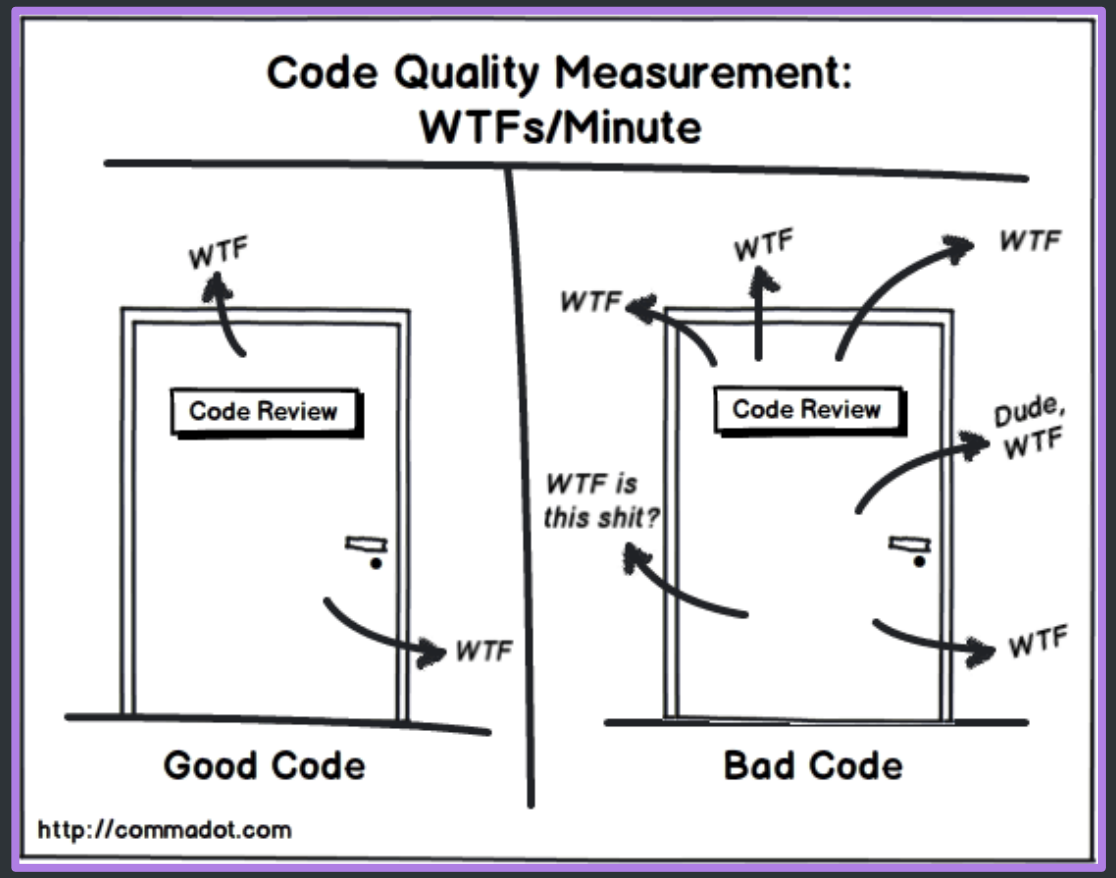
Zephyr™ Project Secure Development Lifecycle

New Zephyr™ Project Features

- Take new features through Security Risk Assessment
  - Security Risk Assessment determines what security review takes place
  - Security features get extra scrutiny
- Review based on:
  - Initial touch feature review
  - Use of cryptography
  - Compliance with Threat Model
  - Incorporation into Security Architecture

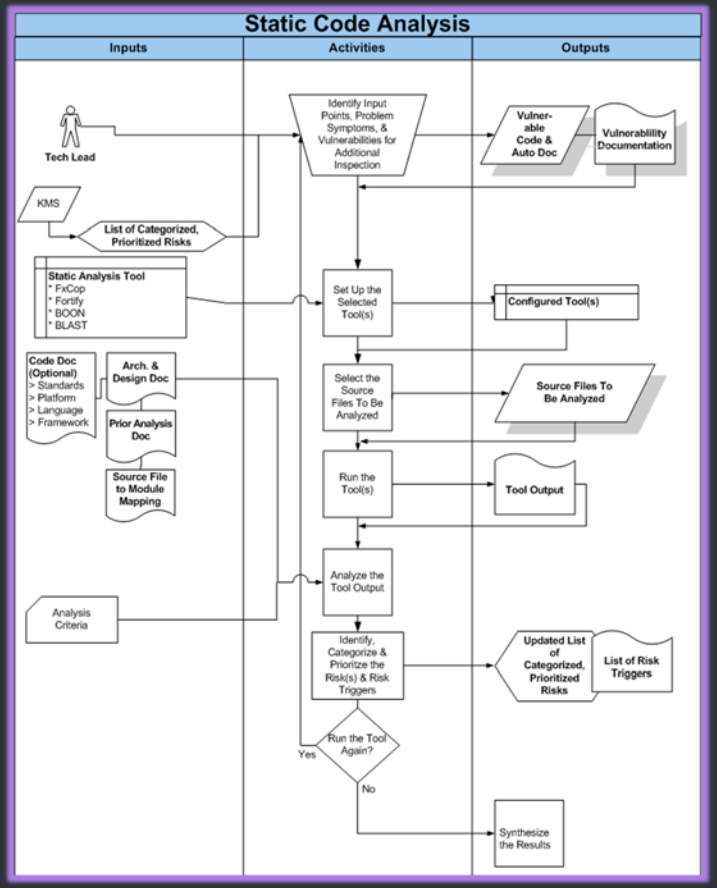
Zephyr™ Project Code Review

- Why do Code Review?
  - No one writes perfect code
  - Ensure code complies with rest of communities expectations
- All code goes through review in Gerrit
  - Ensure appropriate string/memory function use
  - Validate user input
  - Readability & Maintainability
  - Correct Functionality
  - Security review of all security relevant code



Zephyr™ Project Static Code Analysis

- Why Static Code Analyze Zephyr?
  - Developers aren't perfect at code review either
  - Static Analysis (despite significant false positives) identifies low-hanging functional and security defects
  - It also finds some complex and hard to identify issues
- All code goes through static code analysis
  - Fix all identified significant issues
  - Considering utilizing https://scan.coverity.com/ as project solution



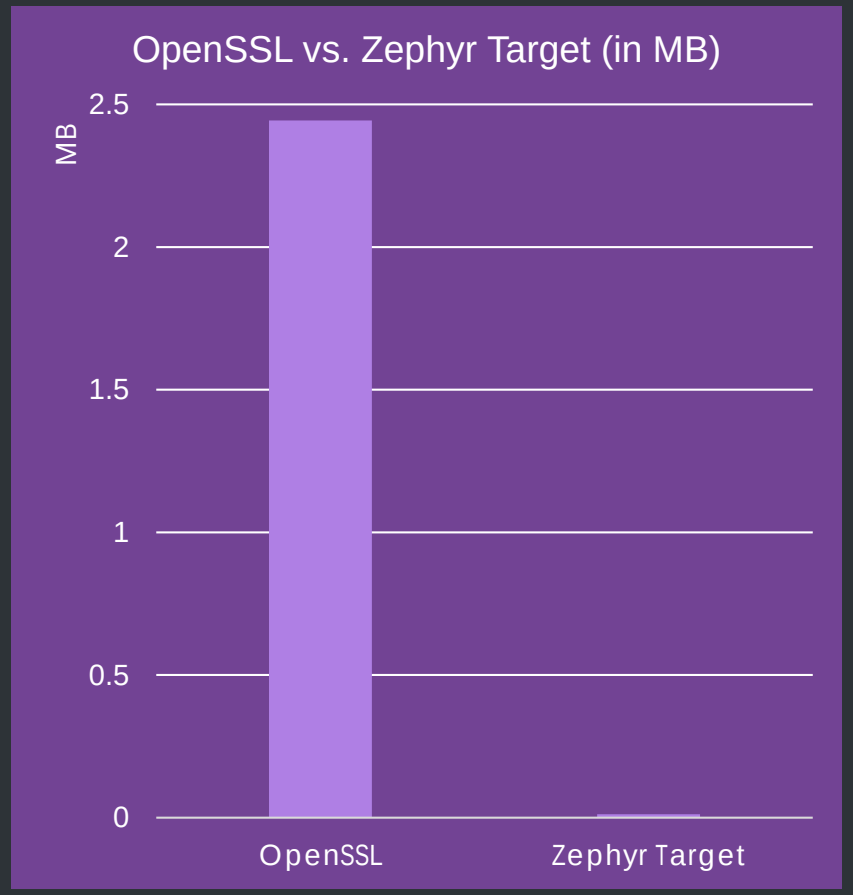
Zephyr™ Project Survivability

- Why Survivability?
  - Projects Upstream of Zephyr will have security vulnerabilities discovered
  - Ensure Zephyr knows how to respond when a security issue is found
- Team ready to respond to security issues
  - Project Practices “Responsible Disclosure”

TinyCrypt

Zephyr™ Project Crypto Needs

- Cryptographic protections have become standard for almost all forms of communication
  - If Zephyr is going to talk to things, it needs to talk crypto
- Complication: Standard cryptographic libraries like OpenSSL are orders of magnitude larger than Zephyr target platforms.
  - What to do?



EUREKA!

Let’s see what’s available!

TinyCrypt Is Born

- Cryptographic Experts in Intel Labs had been looking at the problem
  - They had an internal codebase they had already been working on which met Zephyr's needs
- Zephyr knew this codebase would be useful for other projects
  - TinyCrypt was made its own project
  - Upstream Maintainer: Constanza Heath
  - https://github.com/01org/tinycrypt
  - Goals:
    - Minimize code size of each crypto primitive
    - Minimize dependencies among primitive implementations
    - Multiple architecture

TinyCrypt Provides

- SHA-256
  - Hash function
  - Defined in NIST FIPS PUB 180-4
- HMAC-SHA256
  - Message authentication code
  - Defined in RFC 2104
  - Requires SHA-256
- HMAC-PRNG
  - Pseudo-random number generator
  - Defined in NIST SP 800-90A
  - Requires SHA-256 & HMAC-SHA256
- AES-128
  - Block cipher
  - Defined in NIST FIPS PUB 197
- AES-CBC
  - AES mode of operation
  - Defined in NIST SP 800-38A
  - Requires AES-128
- AES-CTR
  - AES mode of operation
  - Defined in NIST SP 800-38A
  - Requires AES-128
- AES-CMAC
  - Message authentication code
  - Defined in NIST SP 800-38B
  - Requires AES-128
- AES-CCM
  - Authenticated encryption
  - Defined in NIST SP 800-38C
  - Requires AES-128
- ECC-DH
  - Key Exchange
  - Defined in RFC 6090
  - Requires ECC auxiliary functions
- ECC-DSA
  - Digital Signature
  - Defined in RFC 6090
  - Requires ECC auxiliary functions

Can be utilized by TLS libraries

Looking Forward

Future Directions

- Memory Protections
- Device Management and Updates
- APIs to support vendor specific Crypto implementations (SW/HW)
- Secure Key Storage
- Your Ideas?

Summary

- Zephyr Project is…
  - Being proactive about security
  - Looking at the environment that we are deploying into for security concerns
  - Ensuring software is being constructed correctly from a security perspective
  - Including a new, novel cryptographic library in TinyCrypt
  - Looking for feedback on what's useful for future directions of security

Visit Us!
Booth #108
Zephyr™ Project Demos from our member companies

www.zephyrproject.org

Other Zephyr™ Project Sessions @ ELC/OpenIoT		
Zephyr™ Project Security	Monday, April 4, 2016	Harbor Ballroom E
Zephyr™ Project Overview	Tuesday, April 5, 2016	
Power Management in Zephyr™ RTOS	Wednesday, April 6, 2016	

Zephyr™

www.zephyrproject.org

Zephyr Kernel – Key Features

Multi-threading services, including both priority-based, non-preemptive fibers and priority-based, preemptive tasks (with optional round robin time-slicing).

Interrupt services, including both compile-time and run-time registration of interrupt handlers, which can be written in C or assembly language.

Inter-thread synchronization services, including binary semaphores, counting semaphores, and mutex semaphores.

Inter-thread data passing services, including basic message queues, enhanced message queues, and byte streams.

Memory allocation services, including dynamic allocation and freeing of fixed-size or variable-size memory blocks.

Zephyr Kernel – Key Features

Power management services, including tick-less idle and an advanced idling infrastructure.

Highly configurable, allowing an application to incorporate only the capabilities it needs, and to specify their quantity and size.

Zephyr requires all system resources to be defined at compile-time to reduce code size and increase performance.

Provides minimal run-time error checking to reduce code size and increase performance. An optional error checking infrastructure is provided that can assist in debugging during application development

Library based RTOS ("kernel-less")

Best-of-Breed Tools

- Kbuild - The build system of the Linux kernel
- Kconfig - The configuration system of the Linux kernel
- Rich and Powerful SDK developed specifically for Zephyr and powered by the Yocto project:
  - 5 different cross-compilers for all supported architectures and platforms
  - Support for baremetal c library, based on newlib
  - Host tools needed for debugging and downloading images (flashing) into target platforms
- Builds natively on Linux*, MacOS* and Microsoft* Windows
- Building on all various operating systems using Docker containers