BEHIND THE SCENES OF THE DEFCON 27 BADGE

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BADGE HISTORY
GOALS

• CREATE A GAME TO ENCOMPASS THE DEFCON EXPERIENCE
• USE TECHNOLOGY TO BRING COMMUNITY TOGETHER
• ACCESSIBLE TO ALL DEFCON ATTENDEES
GAMEPLAY / BADGE QUEST

- States denoted by LED patterns
- Advance to the next state by completing tasks
- Some require discovery of magic tokens
- All require interaction with other people
- When all tasks are complete, celebrate
MCU

- NXP KL27
- ARM-CORTEX M0+
- 64KB FLASH, 16KB SRAM
- DC27: GPIO, I2C, LPTMR, TPM, UART (2)
NFMI

- NEAR FIELD MAGNETIC INDUCTION
- LOW POWER, NON-PROPAGATING FIELD BETWEEN DEVICES
- DESIGNED FOR SHORT RANGE DATA AND / OR AUDIO TRANSFER (< 1M)
- HEARING AIDS, WIRELESS EAR BUDS, BODY AREA NETWORK / TACTICAL
- NXP MIGLO
- NXH2261 = NFMI + ARM
- INTERNAL EEPROM (FIRMWARE) PROGRAMMED VIA I2C ON POWER-UP
- UART TO / FROM KL27
- GPIO FOR STATUS / INTERRUPT
- 10.58MHZ CARRIER, 596KBPS
- CUSTOM MULTI-BADGE DATA TRANSFER CODE BY NXP FOR DC27
- LPBROADCAST_NXH_DC27.EEP.H
• DATA PACKET AKA "PACKET OF INFAMY"
• BROADCAST TO ANY DEVICE WITHIN RANGE
LED DRIVER

- TEXAS INSTRUMENTS LP5569
- 1.5X CHARGE PUMP = HIGH VF LEDS @ LOW VIN
- AUTOMATIC POWER SAVE MODE (10UA)
- EACH LED INDIVIDUALLY ADDRESSABLE, DIMMABLE (12-BIT PWM @ 20KHZ)
- CURRENT OUTPUT VARIES PER COLOR, SET ON POWER-UP (8-BIT, 100UA STEP)
MOUNTING OPTIONS

- LANYARD
- LANYARD CLIP
- WATCH STRAP
- HEADBAND
- BROOCH / AMULET
- ???

Mounting Options Diagram
EARLY CONCEPTS

[Image of early concepts with handwritten notes on a piece of paper. Notes include:
- Drill pocket
- Into stone
- Motor on top of LED
- Reverse mount
- Battery
- Glue to flat back of stone]
PROTOTYPING / DEVELOPMENT
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HUNTING FOR TREASURE

• ADVENTURES AT THE TUCSON GEM SHOW
• 48 SHOWS OVER TWO WEEKS, ~50K PEOPLE
• 36 HOURS TO FIND SUPPLIER
• RETAIL VENDORS / HOTEL ROOMS -> WHOLESALE -> MINE OWNER -> FACTORY
Gemstone Fabrication

- Hand cut quartz crystal
- Raw material from Brazil
- Naturally fractured, strength varies
- Dyed colors for non-human badges
- Crafted by Yee on gems & jewellery
GEMSTONE FABRICATION
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FIRMWARE

• 85% OF FLASH (56KB), 33% OF RAM (5.3KB)
• ~3K PHYSICAL SOURCE LINES OF CODE IN DC27_BADGE.C (MAIN)
DEVELOPMENT ENVIRONMENT (SW)

- NXP MCUXpresso IDE 10.2.1
- FRDM-KL27Z SDK 2.4.1
DEVELOPMENT ENVIRONMENT (HW)

- SWD (ARM SERIAL WIRE DEBUG)
- NXP LPC-LINK2
- TAG-CONNECT TC2050-IDC-NL-050-ALL (NORMAL ORIENTATION)
- TRIM ALIGNMENT PINS IF USING W/ MOUNTED GEMSTONE
- VTREF PROVIDES 1.8V I/O LEVEL TO DEBUG PROBE
DEVELOPMENT ENVIRONMENT (HW)

• UART
  • 1.8V @ 115200, 8N1
  • DEBUG OUTPUT / SYSTEM STATUS
  • COMMAND-BASED INTERACTIVE MODE
  • WILL ENTER AUTOMATICALLY IF RX LINE IS PULLED HIGH
  • MUST EXIT W/ CTRL-X

Mates to Harwin M20-8770442 or compatible
PCB FABRICATION
X-RAY
PROGRAMMING / TESTING

• WINDOWS W/ MCUXPRESSO + LPC-LINK2
• CMD SCRIPT TO PROGRAM KL27
• POWER ON SELF TEST
• INSPECTION OF LEDS (VISIBLE) AND PIEZO (AUDIBLE)
• DETECTION / CONFIGURATION OF NXH2261 + LP5569
FINAL ASSEMBLY
NUMBERS

- **HUMAN, WHITE**: 26,500
- **GOON, RED**: 550
- **SPEAKER, BLUE**: 375
- **VENDOR, PURPLE**: 250
- **PRESS, GREEN**: 250
- **VILLAGE, ORANGE**: 250
- **CONTEST, YELLOW**: 250
- **ARTIST, LIGHT BLUE**: 100
- **CFP REVIEW, GREY**: 45
- **UBER, BLACK**: 20

(BEFORE GEMSTONE ATTACHMENT)
CHALLENGES / INSIGHTS

• TIME FRAME
• COMMUNICATION W/ PCB FAB
• USING UNFAMILIAR TECHNOLOGIES / NON-STANDARD MATERIALS
• BREAK PROJECT INTO SMALL BITES
• ALL PROBLEMS HAVE A ROOT CAUSE
BATTERY LIFE

- CR2032 3V LITHIUM COIN CELL
- 225MAH TO 2V
- POWER UP: 4.2MA
- ATTRACT MODE: 2.3 - 4.6MA
- SLEEP MODE (NFMI ENABLED)
  - 0.41 - 2.0MA
  - 0.61MA AVERAGE

- MINIMUM DESIRED LIFE = 4 DAYS (96 HOURS) -> 2.3MAH AVERAGE
FUTURE USE

• DATA TRANSFER
• COVERT MESSAGE PASSING (NO RF SIGNATURE)
• ROBOTICS (LOCATION TRACKING / SENSING)
• BLINKENLIGHTS
• GENERAL PURPOSE ARM DEV. ENVIRONMENT
• ???
A GLOBAL EFFORT

BLUE MARBLE, RETO STÖCKLI, NASA EARTH OBSERVATORY
RESOURCES

• DC27 HARDWARE HACKING VILLAGE (HHV)
• EXTRA MATERIALS (GEMSTONES, COMPONENTS, BATTERIES)
• REAL-LIFE ENGINEER FROM NXP
• DESIGN DOCUMENTATION, CODE, ETC.
  • www.grandideastudio.com/portfolio/defcon-27-badge/
ENJOY THE CON!

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