**COP Dismounted**

**System Design Description**

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# Scope

## Identification

This document describes the system design of the dismounted version of the Common Operations Picture (COP) situational awareness platform. The a Dismounted COP is achieved by scaling the full COP, as defined by the SiteWare Tracking Server system (ref. main project) to fit a portable device and adding required security, communication and location measures.

## System overview

The system is a Dismounted COP, enabling military, disaster and other required personal to gain an overview of the battlefield, crises or other situation.

The system allows for integration with other military and disaster systems as defined by the Systematic SiteWare Track Server system (ref. main project).

The Dismounted COP must be able to transmit its current location to the tracking server, as well as receive tracking and other information from the server about units and activities in the area.

The system must be battery powered, mobile and operational under extreme conditions and while wearing gloves.

An overall system drawing may be seen in Figure 1.



Figure 1: System drawing of the Dismounted COP.

## Document overview

This document details the overall system design and its purpose is to guide the detailed design of the dismounted COP to achieve the optimal solution while keeping the overall goal abreast as well as document any rationales of rejected technologies or designs and pinpoint risks and areas with tight requirement traceability (areas where extra care must be taken to meet requirements).

# Referenced documents

|  |  |  |
| --- | --- | --- |
| **Doc. ID** | **Name** | **Description** |
| STSSvA4 | SiteWare Tracking server system | The complete documentation of the SiteWare Tracking server system which this Dismounted COP is a portable version of. |
| SOW |  | Statement of work from main contractor. |
|  |  | Q&A regarding SOW from main contractor. |
| CLi-ionvB | Cobolt Li-ion specification | Details about the performance, weight and handling of the Cobolt Li-ion power cell. |
| GSMv5 |  |  |
| SATv6 |  |  |
| WLANv7 |  |  |
| RFv8 |  |  |
| BTv2 |  |  |

# System-wide design decisions

In order to best understand the design decisions, risks and challenges it is beneficial to have a comparable device to measure against. For that purpose the Apple iPad is well suited, as it is similar in physical dimensions and capabilities. In the table below may be seen the design specifications for the Apple iPad.

|  |  |
| --- | --- |
| Weight excl. battery | 480g |
| Battery weight | 250g |
| Battery power | 25Wh |
| Battery type | Phosphate Li-ion = 100Wh/kg |
| Battery durability | Up to 10 hours (9 hours using GSM) |
| Display | 9,7” touch screen |
| Communication | Wi-Fi, USB, GSM, Bluetooth |

## General considerations

Due to the vide spread use of much of the technology employed in this project in civilian industry (GSM modules, GPS modules, touch screens, Wi-Fi, etc.) it is a general design choice that COTS is used whenever possible and as little custom design as possible. As an example of this there is the GSM capability. It is naturally possible to design a Quad-band antenna amplifier and LNA, design the print-board with oscillator, antenna, microcontroller, etc., and write the code to control modulation and protocol. Test and approve EMC and ensure that the noise, both internal and external do not interfere with system. Or a complete High-end module where all this has already been done and all tests has been performed and which has already proven its worth in real life. The latter solution is preferable when the unit count is not very high, for GSM modules in the order of 1 million.

## Weight and power consideration

At present the Cobolt Li-ion batteries support the highest energy concentration of 160Wh/kg, and the design will therefore use this as a basis for creating the power architecture – this is not a design constraint, and should better technology emerge naturally it should be considered.

The safety aspect of using anything with this high a energy density will not be considered, as it is not a requirement and any problems regarding transportation and storage of the batteries falls to the main contractor.

As the requirements for the Dismounted POD’s critical operation time is 12 hours and it has a 10-12” display this means it requires more power and for a longer time than the comparable device. It also requires more back-light and communication. To accommodate these requirements it is estimated that a minimum of 400g of Cobolt Li-ion is required, i.e. 64Wh of power.

As the battery already consume half the permitted weight much consideration must be taken into the design of the frame and screen, as comparable device weighs 480g without battery, leaving only 120g extra for the added durability (rubber protection, harness, …) and communication. It is believed that this will be a major design risk and must be reduced early in the implementation process.

## Battery life and usage considerations

Even with 64Wh it is not realistic to run the backlight at 1000 candela per square meter for 12 hours, and also the communication is a limitation (see communication considerations). Therefore a definition of critical operations will be set up to guide the design:

|  |  |  |
| --- | --- | --- |
| **Usage** | **Description** | **Time** |
| Backlight at 1000cd/m2\*1 | Maximum backlight – should be used under very bright light to see while temporarily in direct sunlight. | 3 hours |
| Backlight at 500cd/m2\*1 | Normal backlight – should be used under normal lighting conditions. | 12 hours |
| Backlight at 100cd/m2 | Low backlight – should be used in poor lighting conditions. | >12hours |
| Active data transmission\*2 | By active data transmission is meant the actual transmission of the data by the physical layer (magnetic waves in one form or other). If new is received every minute and transmission takes 5 seconds (depending on amount and signal strength (retransmissions)) then the system can be operational for 60/5 \* 2 = 60 hours. Naturally any duration above 12 hours is not guaranteed. Active data transmission includes speech. | 2 hours |

\*1 for numbers between 500 and 1000 cd/m2 please refer to the operational time chart for details.

## User interfacing consideration

Due to the requirement that the Dismounted COP must be used with gloves there are limitations on the accuracy of the touch, especially if moving about or in a volatile situation. The design focus must therefore be on simplicity and the system must be able to cope with incorrect or double presses. Furthermore, due to the very limited interfacing capabilities of a gloved hand, an administration mode may be beneficial, e.g. using the USB interface to attach a keyboard and then simply supplying the administrator with a command prompt. The administration mode is only for setup and utility functions, never for normal or critical operations.

The glove is considered to be a fingered glove and not a mitten.

## Communication considerations

As the main SiteWare trace server is designed to be a command center and be hosted in a large van or trailer it is not feasible to support the same forms of communication. For example the use of low frequency RF to communicate over long distances requires a large antenna and high power output, which is simply not possible. The SAT communication generally requires a larger antenna and has a higher power requirement than e.g. GSM, but it is a feasible communication media to build into the system.

The system will automatically choose the “best” communication media available based on bandwidth and power consumption.

## Security considerations

The system will use the communication media as-is, and not additional security (encryption) will be added.

## Non-critical design decisions

There are many parts of this project that has successfully been implemented in both civilian and government projects, and these parts may simply be reused, and they are subject to very low risk and will therefore not be considered in this overall design. These elements are considerations regarding:

* Choosing a touch display module
* Choosing a GSM/SAT/BT/Wi-Fi/ISM/GPS module
* Choosing a communication bus for module to CPU communication (e.g. i2c, RS232, …)
* Choosing a specific microcontroller, RAM circuit, Flash drive, etc.
* Choosing a specific charge circuit and transformer.

# System architectural design

## System components

In Figure 2 may be seen the overall elements that comprise the system. These elements are displayed using the SysML notation for a block diagram.

The elements are further broken down in the following sections until a level sufficient for detailed design is achieved. The interfaces are identified and will be described under the section about interfaces.

The individual elements will be described as is required to gain an understanding of the system in the sections following.

Some specific design constraints are transferred from the requirements directly into the design and apply to all elements:

* The handheld device shall be fully operational in the temperature range of: -25 – 80°C.



Figure 2: Element overview

### User display

The User display element encompasses the part of the display that is responsible for conveying information to the user. This includes any required HW acceleration, SW codices and lumen control.

Even though the LCD driver is depicted in the user display block this is a logic placement only, and it is expected that all driver code is executed by the CPU, wit the exception of possible FPGA code required for optimization of encoding/decoding or other raw math processing relating to image processing.

See Figure 3 for a depiction of the inner block diagram for the user display element.



Figure 3: User display inner block diagram

Some specific design constraints are transferred from the requirements directly into the design:

* LCD display size 10-12”
* LCD backlight up to 1000cd/m2

### CPU

The CPU element encompasses the microcontroller and supporting bus and peripherals.

In order to avoid cluttering the diagram a single driver I/O pin is shown. This I/O pin represents all drivers to CPU relationships in the other elements. It is shown communicating with the OS, but where beneficial it may be wired so some of the communication goes directly to the microcontroller or DSP. An example of this could be the Audio I/O – the raw amplified audio input and output may be wired directly to the microcontroller’s ADC and DAC pins, where the driver simply control the levels on these pins and whether they are active.

Also the inner wiring of the CPU/DSP is shown as an example and detailed design may update this.

See Figure 4 for a depiction of the inner block diagram for the CPU element.



Figure 4: CPU inner block diagram

Some specific design constraints are transferred from the requirements directly into the design:

* The handheld device shall as minimum contain a general purpose 1GHz processor and 512MB Ram and 420MHz dedicated DSP processor.

### User input

The User input element encompasses the part of the display that responds to touch and thereby is responsible for receiving input from the user. This includes any required HW debouncing, SW drivers and initialization control.

Even though the Touch driver is depicted in the user display block this is a logic placement only, and it is expected that all driver code is executed by the CPU, with the exception of possible FPGA code required for optimization of touch debounce or other raw math processing relating to touch input processing.

See Figure 5 for a depiction of the inner block diagram for the user input element.



Figure 5: User input inner block diagram

### Location

The Locaiton element encompasses the software and dedicated hardware responsible for maintaining the unit’s current location.

Even though the Location driver is depicted in the Location block this is a logic placement only, and it is expected that all driver code is executed by the CPU. This includes the Bluetooth driver code, with the exception of code executing directly on the Bluetooth module.

The Location capability has a high priority for the customer, and as getting a GPS location fix is not always possible alternatives must be considered. The following may readily be employed, yet this should not be considered a complete list.

* GSM BTS fix

Each Base station (BTS) indirectly sends out its location, as the base station’s location is known and do not change readily. Based on this information and the signal strength it is possible to achieve an approximate location. If multiple BTS’s are within range this fix may be greatly improved.

* SAT fix

The Satellite phone network has a built in GPS capability, yet if SAT phone is functioning then GPS is most likely also, and this is therefore of little value.

* Other units

The Dismounted COP is meant to work in conjunction with other units, and if one or more units are within range (e.g. using ISM), and they are aware of their location a similar fix as was achieved with the GSM BTS can be achieved.

Naturally these techniques and others that are discovered during detailed design may be combined to achieve better accuracy, though if GPS is achievable no further location calculations need be performed – the GPS fix will always take precedence.

See Figure 6 for a depiction of the inner block diagram for the Location element.



Figure 6: Location inner block diagram

### Power

The Power element encompasses the software and hardware responsible for charging the units battery and ensuring that the power is transformed to a suitable level and to report battery status to the CPU.

Even though the Power driver is depicted in the Power block this is a logic placement only, and it is expected that all driver code is executed by the CPU.

See Figure 7 for a depiction of the inner block diagram for the Location element.



Figure 7: Power inner block diagram

Some specific design constraints are transferred from the requirements directly into the design:

* Battery must be chargeable with a 12VDC input

### Frame

The Power element encompasses the hardware parts in the unit’s exterior which is not the touch display.

See Figure 8 for a depiction of the inner block diagram for the Frame element.

Shock absorption in this case is not only the outer protection, but also the mounting of modules and circuits to ensure that they can sustain a certain impact without dislodging, as well as any spring mounting required.

The USB plug is for administration of the unit only, and is not designed to be used by the user.



Figure 8: Frame inner block diagram

Some specific design constraints are transferred from the requirements directly into the design:

* The handheld device shall perform according to IP-67 classification.
* The battery in the handheld device shall be replaceable on sight.

### Communication

The Communication element encompasses all the external data interfaces of the unit, including hardware, software and modules. It furthermore has the responsibility of making any location determining information that it gains through or because of its data interfaces available to the Location element.

Even though the Communication driver is depicted in the Communication block this is a logic placement only, and it is expected that all driver code is executed by the CPU, with the exception of any code executing on the individual modules.

Due to strict power needs the Communication element will power down any modules currently not in use, e.g. if no Bluetooth headset is in use the Bluetooth headset is shut down. If the ISM communication channel is employed all other data communication modules is shut down (GSM, SAT, WLAN).

The Communication driver will, based on a prioritised list attempt to establish contact with less power consuming communication channels at a regular interval to ensure that the lowers power consumption is achieved, e.g. if the SAT communication channel is employed then the GSM and ISM bands are polled to see if one or the other can take over. Naturally as this polling also consumes power it should be done at an optimal interval relating to power consumption for poll, power consumption for active communication channel, probability of success.



Figure 9: Communication inner block diagram

### Audio

The Audio element encompasses functionality required to play audio on the unit’s speakers and receive audio input form the microphone, as well as software to control this (volume, on/off, …).

Even though the Audio driver is depicted in the Audio block this is a logic placement only, and it is expected that all driver code is executed by the CPU.

The audio element is expected to be used only with respect to conference calls, where the unit is used by a group of people, or to allow the central server to hear what is going on. For person-to-person communication it is recommended that a Bluetooth headset is employed.

It is therefore not a design consideration that the Audio amplifiers has to be very power efficient, as the 12 hours running time to not include them (2 hours active data transmission also greatly reduced this number).



Figure 10: Audio inner block diagram

## Concept of execution

This paragraph shall describe the concept of execution among the

system components. It shall include diagrams and descriptions showing the dynamic relationship

of the components, that is, how they will interact during system operation, including, as applicable,

flow of execution control, data flow, dynamically controlled sequencing, state transition diagrams,

timing diagrams, priorities among components, handling of interrupts, timing/sequencing

relationships, exception handling, concurrent execution, dynamic allocation/deallocation, dynamic

creation/deletion of objects, processes, tasks, and other aspects of dynamic behavior.

## Interface design

Audio shall be directly wired to the microcontroller DAC/ADC

This paragraph shall be divided into the following subparagraphs to

describe the interface characteristics of the system components. It shall include both interfaces

among the components and their interfaces with external entities such as other systems,

configuration items, and users. Note: There is no requirement for these interfaces to be

completely designed at this level; this paragraph is provided to allow the recording of interface

design decisions made as part of system architectural design. If part or all of this information is

contained in Interface Design Descriptions (IDDs) or elsewhere, these sources may be

referenced.

### Interface identification and diagrams

This paragraph shall state the project-unique

identifier assigned to each interface and shall identify the interfacing entities (systems,

configuration items, users, etc.) by name, number, version, and documentation references, as

applicable. The identification shall state which entities have fixed interface characteristics (and

therefore impose interface requirements on interfacing entities) and which are being developed

or modified (thus having interface requirements imposed on them). One or more interface

diagrams shall be provided, as appropriate, to depict the interfaces.

### 4.3.x (Project-unique identifier of interface)

This paragraph (beginning with 4.3.2) shall identify

an interface by project-unique identifier, shall briefly identify the interfacing entities, and shall be

divided into subparagraphs as needed to describe the interface characteristics of one or both of

the interfacing entities. If a given interfacing entity is not covered by this SSDD (for example, an

external system) but its interface characteristics need to be mentioned to describe interfacing

entities that are, these characteristics shall be stated as assumptions or as "When [the entity not

covered] does this, [the entity that is covered] will ...." This paragraph may reference other

documents (such as data dictionaries, standards for protocols, and standards for user interfaces)

in place of stating the information here. The design description shall include the following, as

applicable, presented in any order suited to the information to be provided, and shall note any

differences in these characteristics from the point of view of the interfacing entities (such as

different expectations about the size, frequency, or other characteristics of data elements):

a. Priority assigned to the interface by the interfacing entity(ies)

b. Type of interface (such as real-time data transfer, storage-and-retrieval of data, etc.) to be implemented

c. Characteristics of individual data elements that the interfacing entity(ies) will provide, store, send, access, receive, etc., such as:

1) Names/identifiers

a) Project-unique identifier

b) Non-technical (natural-language) name

c) DoD standard data element name

d) Technical name (e.g., variable or field name in code or database)

e) Abbreviation or synonymous names

2) Data type (alphanumeric, integer, etc.)

3) Size and format (such as length and punctuation of a character string)

4) Units of measurement (such as meters, dollars, nanoseconds)

5) Range or enumeration of possible values (such as 0-99)

6) Accuracy (how correct) and precision (number of significant digits)

7) Priority, timing, frequency, volume, sequencing, and other constraints, such as whether

the data element may be updated and whether business rules apply

8) Security and privacy constraints

9) Sources (setting/sending entities) and recipients (using/receiving entities)

d. Characteristics of data element assemblies (records, messages, files, arrays, displays, reports, etc.) that the interfacing entity(ies) will provide, store, send, access, receive, etc., such as:

1) Names/identifiers

a) Project-unique identifier to be used for traceability

b) Non-technical (natural language) name

c) Technical name (e.g., record or data structure name in code or database)

d) Abbreviations or synonymous names

2) Data elements in the assembly and their structure (number, order, grouping)

3) Medium (such as disk) and structure of data elements/assemblies on the medium

4) Visual and auditory characteristics of displays and other outputs (such as colors,

layouts, fonts, icons and other display elements, beeps, lights)

5) Relationships among assemblies, such as sorting/access characteristics

6) Priority, timing, frequency, volume, sequencing, and other constraints, such as whether

the assembly may be updated and whether business rules apply

7) Security and privacy constraints

8) Sources (setting/sending entities) and recipients (using/receiving entities)

e. Characteristics of communication methods that the interfacing entity(ies) will use for the interface, such as:

1) Project-unique identifier(s)

2) Communication links/bands/frequencies/media and their characteristics

3) Message formatting

4) Flow control (such as sequence numbering and buffer allocation)

5) Data transfer rate, whether periodic/aperiodic, and interval between transfers

6) Routing, addressing, and naming conventions

7) Transmission services, including priority and grade

8) Safety/security/privacy considerations, such as encryption, user authentication,

compartmentalization, and auditing

f. Characteristics of protocols the interfacing entity(ies) will use for the interface, such as:

1) Project-unique identifier(s)

2) Priority/layer of the protocol

3) Packeting, including fragmentation and reassembly, routing, and addressing

4) Legality checks, error control, and recovery procedures

5) Synchronization, including connection establishment, maintenance, termination

6) Status, identification, and any other reporting features

g. Other characteristics, such as physical compatibility of the interfacing entity(ies)

(dimensions, tolerances, loads, voltages, plug compatibility, etc.)

# Requirements traceability

This paragraph shall contain:

a. Traceability from each system component identified in this SSDD to the system

requirements allocated to it. (Alternatively, this traceability may be provided in 4.1.)

b. Traceability from each system requirement to the system components to which it is

allocated.

# Notes

This section shall contain any general information that aids in understanding this

document (e.g., background information, glossary, rationale). This section shall contain an

alphabetical listing of all acronyms, abbreviations, and their meanings as used in this document

and a list of any terms and definitions needed to understand this document.

# A. Appendixes

Appendixes may be used to provide information published separately for

convenience in document maintenance (e.g., charts, classified data). As applicable, each

appendix shall be referenced in the main body of the document where the data would normally

have been provided. Appendixes may be bound as separate documents for ease in handling.

Appendixes shall be lettered alphabetically (A, B, etc.).

# Niv 1

## Niv 2

### Niv 3

#### Niv 4