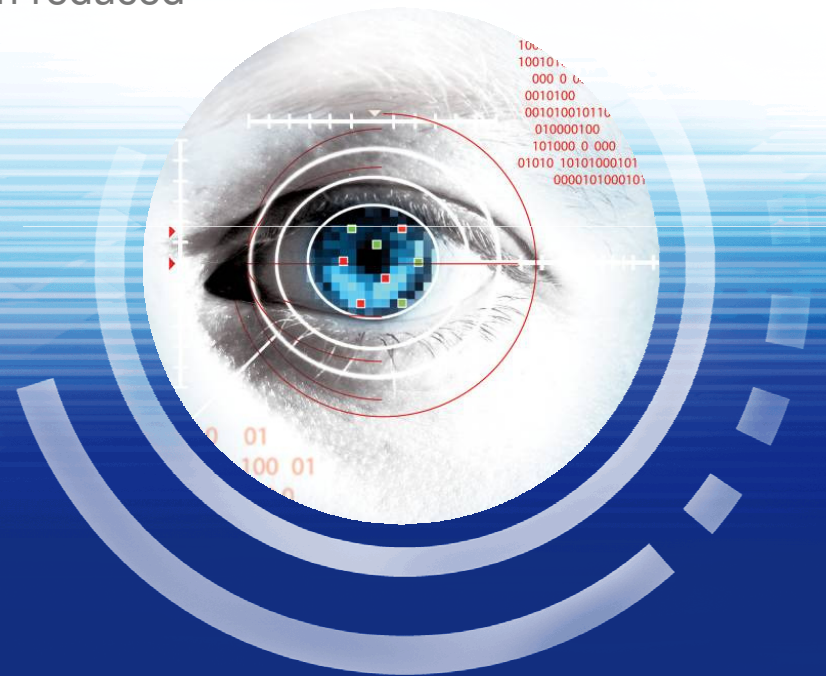


## The Hidden Decisions Behind Covert Surveillance

The challenge of increased performance requirements with reduced power, size and weight



European Microwave 2011 – Defence & Security Forum

Steve Williamson – Principal Engineer

## The Hidden Decisions Behind Covert Surveillance - Agenda

### Agenda:

- 1 Introduction**
- 2 The battlefield today**
- 3 The hidden decisions**
- 4 prism200 – Case study 1**
- 5 Sidewinder™ – Case study 2**
- 6 Summary**

## The Hidden Decisions Behind Covert Surveillance - Introduction

**Cambridge Consultants is one of Europe's leading design and development houses, established for 50 years**

We employ around 300 engineers, designers, scientists and support staff providing

- Independent assessment of technologies and solutions
- Development of leading edge hardware and software demonstration systems
- Transition of proof of concept systems to deployable products



50  
YEARS  
OF INNOVATION



THE QUEEN'S AWARDS  
FOR ENTERPRISE:  
INNOVATION  
2011



THE QUEEN'S AWARDS  
FOR ENTERPRISE:  
INTERNATIONAL TRADE  
2009

## The Hidden Decisions Behind Covert Surveillance - The battlefield today

**Today's battlefield is not limited by borders. Locations range from local and domestic to international, using land, sea, air and space.**

Requirements for operational use have never been more demanding, with performance only limited by the 'laws of physics'.

- Range of users across all forces
  - Police
  - Army, Navy, Air Force
  - SF, SWAT
- Technology requirements almost identical
  - Environment usually the key differentiator
- Adversaries have become increasingly technically capable
  - Surveillance aware



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## The Hidden Decisions Behind Covert Surveillance - The hidden decisions

### Delivering low power, low weight systems requires a combination of approaches embedded within the overall development programme

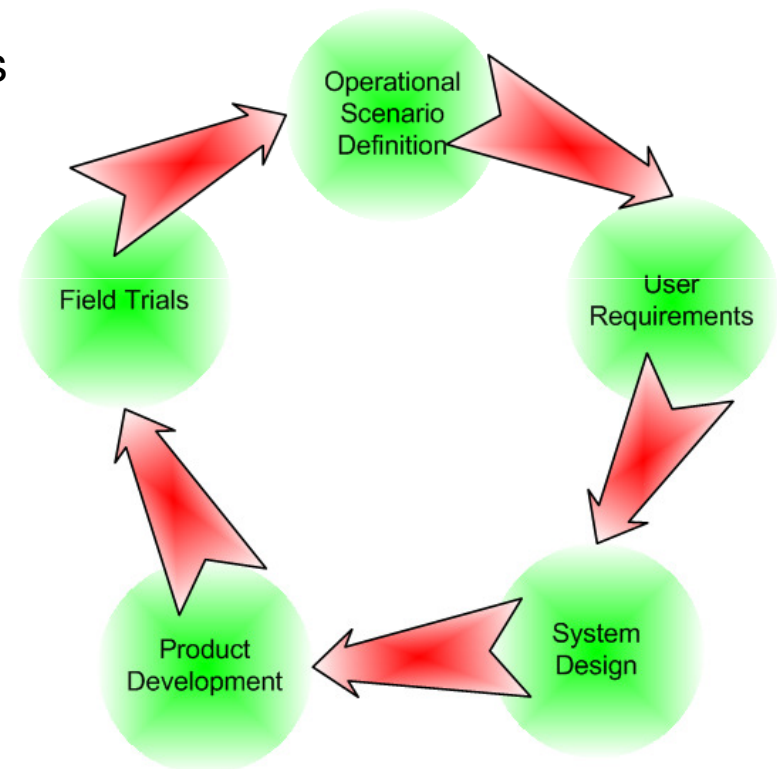
Develop the key requirements from a user perspectives by examining operational scenarios

#### Identify

- Power, size, weight, performance and cost

#### Implementation trade-offs

- Off-the-shelf versus bespoke
- Radical versus incremental innovation



## The Hidden Decisions Behind Covert Surveillance - Scenario Definitions

Identifying the usage scenarios for any equipment is important for a successful development. Engaging with the end user ensures ‘buy in’ to the final product.

- Develop the key requirements from a user perspectives by examining operational scenarios and compare them to **ALL** perceived requirements.

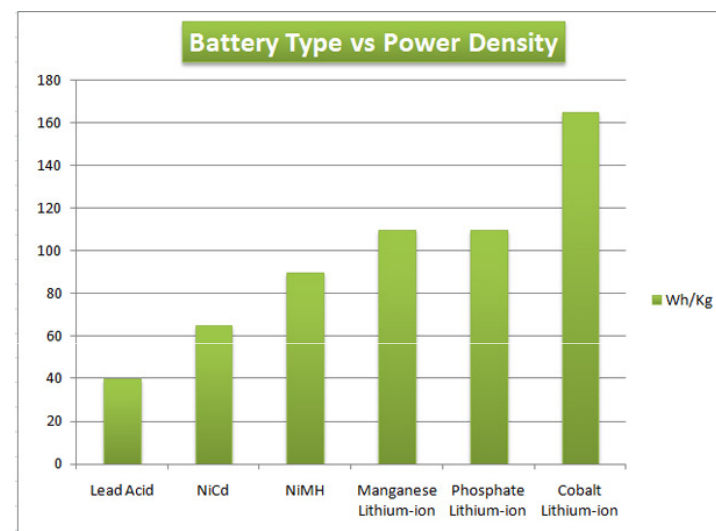
Scenario	Operational Modes					
	Through Wall Tracking	GPS Location	WiFi Link	GSM Detection	Blue/Red Force Identification	Night Display
1	Essential	Essential	Essential	Essential	Desirable	Unnecessary
2	Essential	Desirable	Unnecessary	Desirable	Desirable	Essential
3	Essential	Desirable	Desirable	Essential	Desirable	Unnecessary
4	Unnecessary	Desirable	Desirable	Essential	Unnecessary	Unnecessary

- This comparison should lead to:
  - Reduced and focused set of requirements
  - Simplification/rationalisation of the design
  - Identification of challenging design requirements
    - IP ratings, battery life, operating temperature

## The Hidden Decisions Behind Covert Surveillance - Power

**Power is often the driver in portable battlefield systems, directly affecting size and weight. Batteries are evolving rapidly due to portable consumer devices.**

- Main technologies
  - Lead-Acid : Traditionally used for bulk storage
  - NiMH : Now at its development limit
  - NiCd : Phasing out due to toxicity
  - Li-Ion : Highest energy density
- Portable/consumer electronic equipment driving:
  - Increased capacity
  - Shape and size
  - Vehicle technology driving charging rate
- Standardisation a major issue
  - Common products
  - ‘AA’ still very popular
    - Easy to obtain ‘locally’

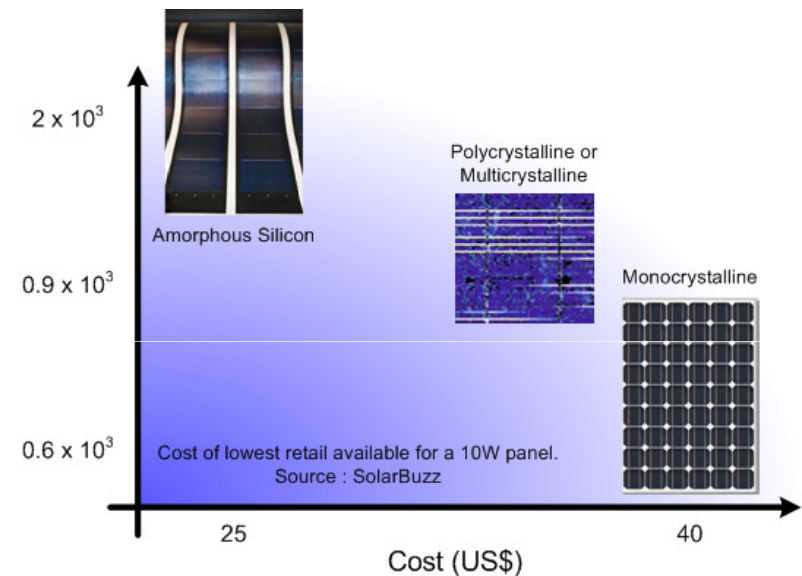


## The Hidden Decisions Behind Covert Surveillance - Power

### Solar power is becoming more accessible as a charging source for battery powered equipment.

Use of solar power for direct source or charging batteries is becoming common place

- Becoming more robust and flexible
  - Amorphous silicon
- \$1 per Watt manufacturing cost
  - Can be coloured for camouflage



### 'Solar Soldier' Project

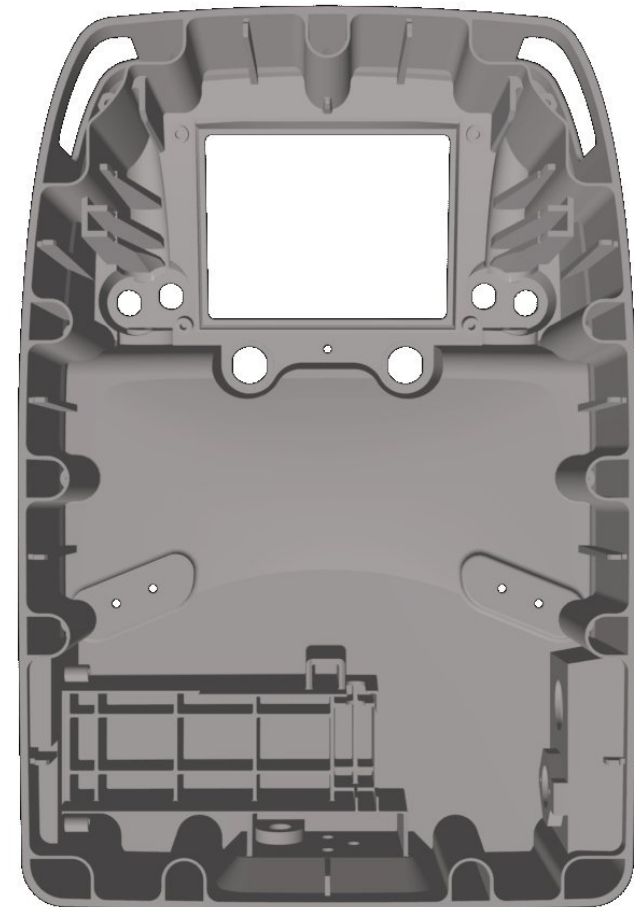
- EPARC and MoD funded research with DSTL and UK universities
  - 50 percent lighter power source with solar and a thermoelectric-powered system
  - Due to complete Q4 2011



## The Hidden Decisions Behind Covert Surveillance - Size and Weight

**Size and weight are only limited by the physical volumes within the equipment.  
Material choices can help improve product ruggedness and weight, despite size.**

- Again, usage scenarios drive requirements
  - Weight limit
    - 1kg is normal one hand weight limit
    - End user's opinion can be very polarised
    - Use of metals such as magnesium
  - Size
    - Palm sized ► Is it a key requirement?
  - Environmental
    - UV Resistant ► Limits use of some plastics
    - Sunlight exposure implies display issues
    - Minimise case parts to reduce number of seals
  - Drop test limits
    - Rigidity/bulk not always the solution
    - Shock mounting



## The Hidden Decisions Behind Covert Surveillance - Size and Weight

**Simplified interfaces to operate equipment reduce training times and reduce the need for skilled operators, offering manufacturers potential for volume supply.**

- Cont..

- Human factors
  - Gloved operation?
  - Removable batteries ► more seals
- MMI
  - More buttons ► more seals
  - Daylight and/or night viewable
  - Required beyond on/off/standby?



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## The Hidden Decisions Behind Covert Surveillance - prism200

### A key challenge at the start of the programme was that users requirements were ill-defined

Capability gap was easy to describe along with customer desire to meet it

Requirements were less easy to define

- Customer wish lists with no defined means of measurement

We took a step back...

*How, when and where will it be used?*

*What is a wall?*

*What information is it desirable to provide?*

*How is the product to be packaged?*

*What is a room?*

*What information is it essential to provide?*

*How is it to be sold and supported?*

**Understanding the user requirements and their implications defines the system constraints and what is required to meet them, and hence the power required**

## The Hidden Decisions Behind Covert Surveillance - prism200

We evolved the design through a number of prototypes to determine performance, feasibility and define product features from requirements



***prism100***

Initial Development System



***prism200*** Prototype

Handheld Proof of Concept



***prism200***

Full Production Version

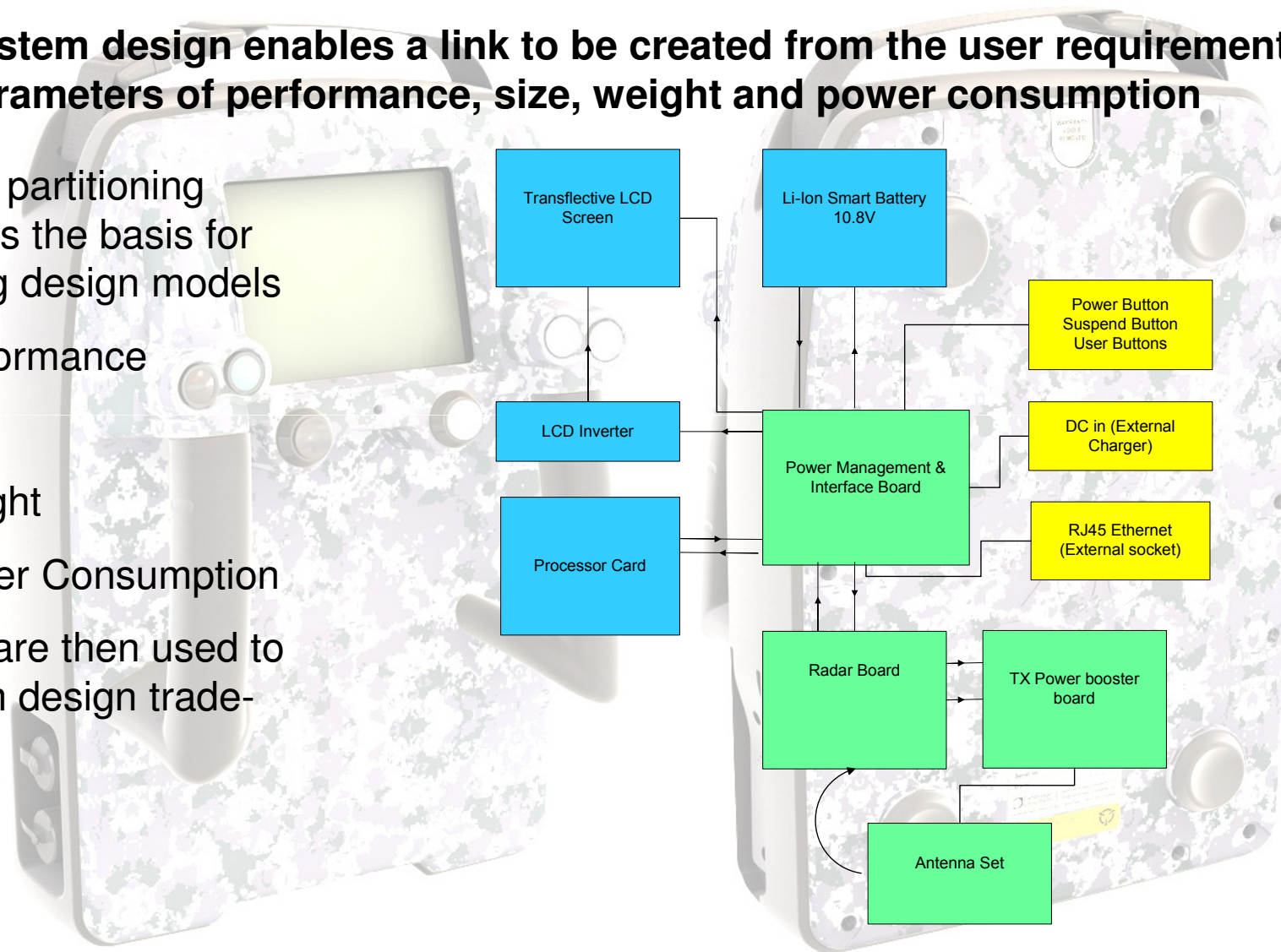
## The Hidden Decisions Behind Covert Surveillance - prism200

**The system design enables a link to be created from the user requirements to key parameters of performance, size, weight and power consumption**

Overall partitioning provides the basis for defining design models

- Performance
- Size
- Weight
- Power Consumption

These are then used to perform design trade-offs



## The Hidden Decisions Behind Covert Surveillance - prism200

**The system design enables a link to be created from the user requirements to key parameters of performance, size, weight and power consumption**

Design trade offs

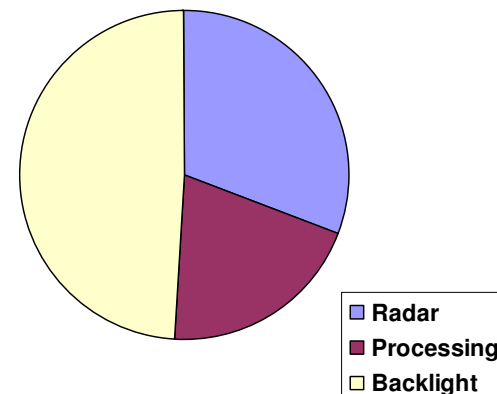
- Backlight usage vs power consumption
- Radar transmit power versus performance

System performance is ultimately limited by processing performance not radar performance

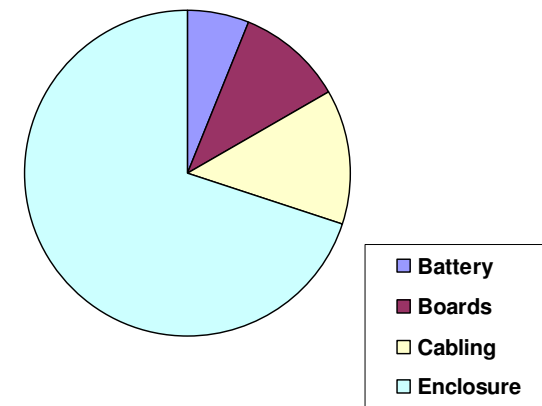
Enclosure to meet the environmental design requirements dominates the weight budget

- Single handed operation
- Limited by the antenna surface area required to resolve objects

Power Consumption Split



Weight Split



## The Hidden Decisions Behind Covert Surveillance - prism200

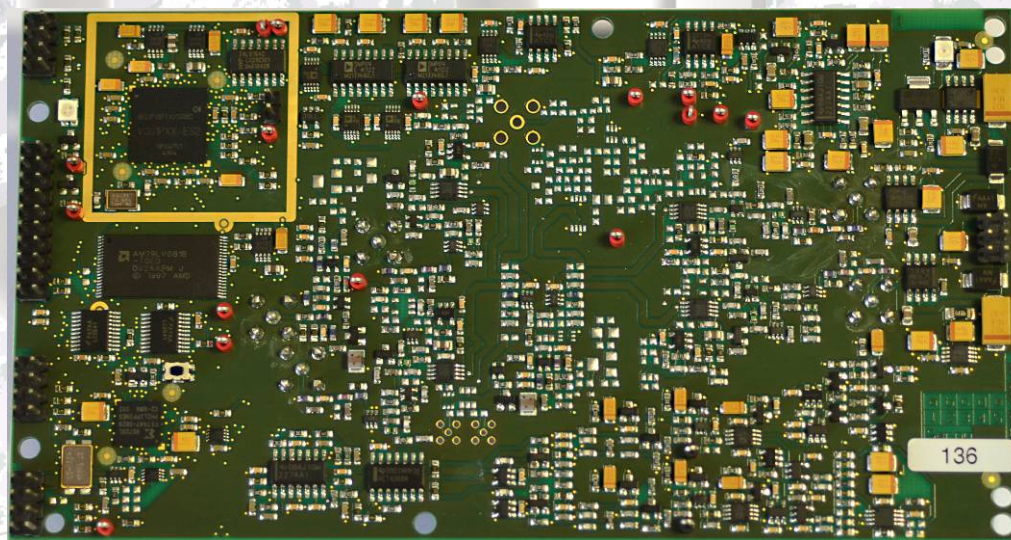
### Implementation uses a combination of COTS components and bespoke components to deliver the required performance

COTS components used for processor, battery and display

- Already optimised for low power / long deployment operation

Radar board provides a transmitter, multiple receivers and target processor on a single PCB with a power consumption of under 3.5W when running continuously

- Target list exported to the main processor for higher level tracking and display



Size: 170mm x 80mm

## The Hidden Decisions Behind Covert Surveillance - Agenda

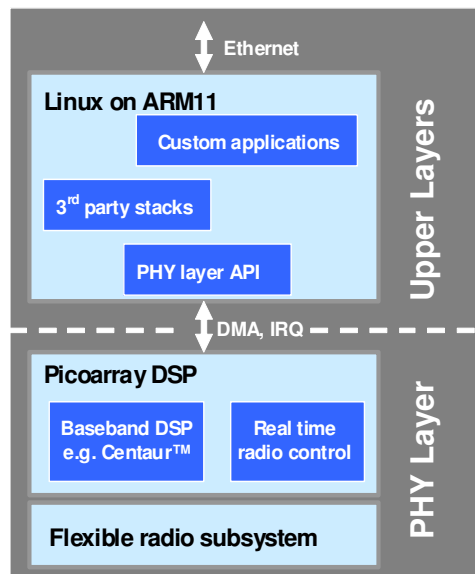
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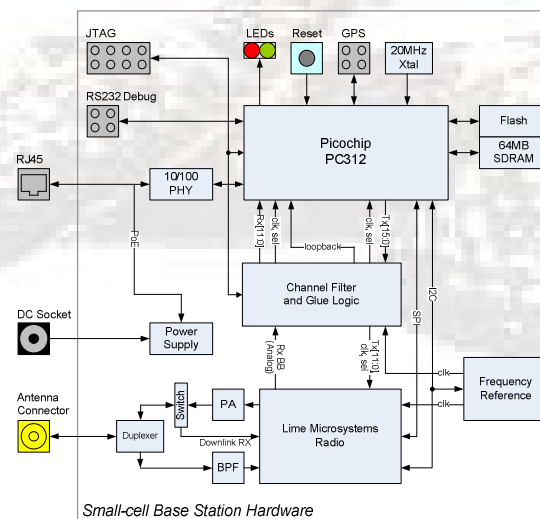
## The Hidden Decisions Behind Covert Surveillance - Sidewinder

**A Small-cell Base Station was identified as being required by end users. It had to be portable, low-power and covertly deployable.**

- Selection of low-power components key to battery operation
  - Power hungry application
  - Picochip PC312 Femtocell Baseband SoC provided DSP performance + low power



Software Environment



Hardware Architecture



## The Hidden Decisions Behind Covert Surveillance - Sidewinder

**Software and hardware system architectures were defined in parallel to ensure functional requirements were met.**

- A feature set was defined in conjunction with potential end-users
  - High-end generic SDR platform
  - Operate from 375MHz to 4GHz
  - Channel BW up to 28MHz
  - Configurable as a minimum for:
    - 2G GSM ► GSM / GPRS / EDGE
    - 3G WCDMA
- Functions to include IMSI grabbing and occupancy monitoring
- Other requirements
  - Low power and portable ► battery powered
  - Variety of timing references
    - IEEE, GPS, network listen

Feature	Specification
<b>Radio channels</b>	Configurable for one of: <ul style="list-style-type: none"> <li>• GSM 850, 900, 1800 or 1900</li> <li>• 3G Band-I [2.1GHz]</li> </ul>
<b>Dimensions</b>	92mm x 80mm
<b>Power</b>	6W (max)
<b>TX Power</b>	+5dBm
<b>RX Sens.</b>	-104dBm (for GSM)
<b>Ant. Port</b>	Single SMA Connector
<b>GPS</b>	Interface to external GPS for PPS
<b>Connectors</b>	Ethernet 100BT Debug – JTAG, UART
<b>Electronic Bill of Materials</b>	< US\$ 200 (1000 off)

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## The Hidden Decisions Behind Covert Surveillance - Summary

**Reducing the burden requires an end-user focussed design approach which also addresses low power and low weight design from conception.**

- Define the usage scenarios early in development
- Contrast what is *essential* from what is *desirable*
  - Power, size and weight can be radically altered at this point
- End-user feedback and experience can validate product concept features against requirements
- Invest time in system partitioning and development of performance models to enable design decisions to be taken in the context of user requirements
- Consider COTS components versus bespoke development
  - Volume pricing may improve competitive edge
  - Shortens development times
- Identify where innovation can provide significant benefits
  - Hardware rarely outweighs the value of algorithms and signal processing

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