Final Report Phase 1:

Project: DPI-NSW Competitive Annual Grants Program Shark Alert & Advice System

Prepared by Mobiddiction for Byron Shire Council

Executive Summary

As part of the NSW Shark Management Strategy (SMS) Competitive Annual Grants Program Byron Shire Council engaged Mobiddiction to research and develop a shark alert device prototype for all water users in coastal locations in the Northern Rivers. The proposed concept system automatically and wirelessly relays the information from the DPI-NSW Shark Smart App to a solar powered, 4G connected alert poles.

Through the use of alerts and advice, the poles will provide real-time visual information to all water users to enable informed decisions without the need to have smart technology in the water.

The system enables the use of data from the SharkSmart app in locations where surf users cannot take personal devices and provides line of sight information to bathers of possible shark interaction risk.

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Introduction

The NSW DPI SharkSmart app has a shark alert service which obtains shark detection information from several sources including VR4G buoys, helicopter surveillance, Smart Drumlines, and alerts entered manually by DPI SharkSmart staff. There are other potential sources of shark detection data, but the DPI SharkSmart program is the highest quality real time data of actionable shark detection events. The design of the system can use any other internet available data, but the DPI data alone has been chosen for now.

Byron Shire Council engaged Mobiddiction looking for a solution to make those alerts usable while not carrying your smartphone, as many beach users do not take their phones onto the beach and almost no beach users have their phone with them while in the water. Within the constraints of typical beach locations - specifically no access to mains power or wired internet connections, we were asked to investigate how to make a "Shark Alert Device" which would display a light when the SharkSmart app has a current local shark alert.

We chose to approach this in a two phase process - firstly demonstrating the technical capability to connect to the data sources and turn on a lamp based on the SharkSmart mobile app API, with some configurable device-specific parameters (such as how close or far a shark detection should be to set the alert off, and how long after a detection the alert lamp should go out). This phase will result in a set of prototype devices which can be trialled in the field. The second phase will build on the results of the first phase and the learnings from deploying the prototypes during the test period, and will consist of specifying and creating suitable enclosures, solar and battery capacity, appropriate lights and light behaviours - and ending up with a design and bill of materials to make production deployable Shark Alert Devices.

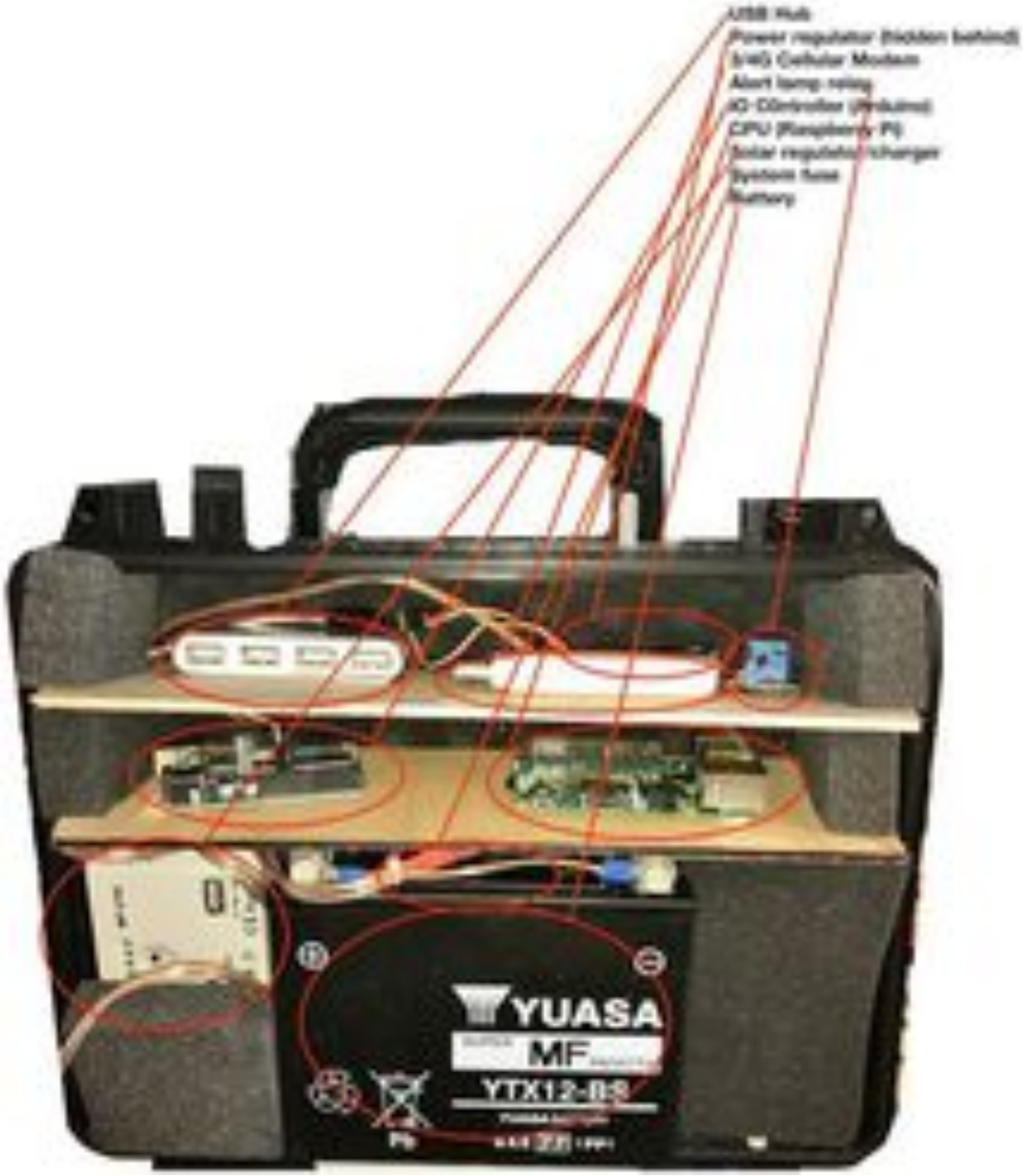
Materials and Methods

Mobiddiction have experience with IoT devices, and are starting with and extending our Mobiconnect IoT platform to build these devices. We are aiming for a design capable of being built and supported for a reasonable lifecycle, and so are aiming as much as possible to use off-the-shelf components that will be available in the future, and to design everything in a modular fashion to that individual changes or component replacement won't require significant redesign effort.

The core of the Mobiconnect IoT platform is the fairly standard "Raspberry Pi plus Arduino" approach taken by many IoT designers for low volume production runs (in the tens or hundreds of units, custom hardware rarely breaks even for production runs of fewer than 5 or 10 thousand units). This gives us a large range of component vendors, and the support and accessory availability of probably the most popular SOC single board computer (the Raspberry Pi) along with the robustness of the most popular microcontroller board (the Arduino). This combination also gives us very well understood building blocks that means finding people to support and extend this solution will be straightforward if needed.

So we use the Mobiconnect IoT's Raspberry Pi 3+ and Arduino Duemilanove as standard for processing/logic and IO/switching duties respectively, which we are extending using an off-the shelf solar charger/regulator charging a lead acid battery from commodity solar panels. We use a USB 3G data modem for internet connectivity.

Each device is remotely configurable, getting it's location and various other operational parameters from the internet, and if uses the SharkSmart API to get the latest shark detection data, which it compares with it's own location configuration and rule-set to determine whether or not to light up it's alert lamp. The system is all mounted in a suitable enclosure, with external solar panels and alert lamp.


USB Hub
Power regulator (hidden behind)
3/4G Cellular Modem
Alert lamp relay
IO Controller (Arduino)
CPU (Raspberry Pi)
Solar regulator/charger
System fuse
Battery
YUASA
MF
YTX12-BS

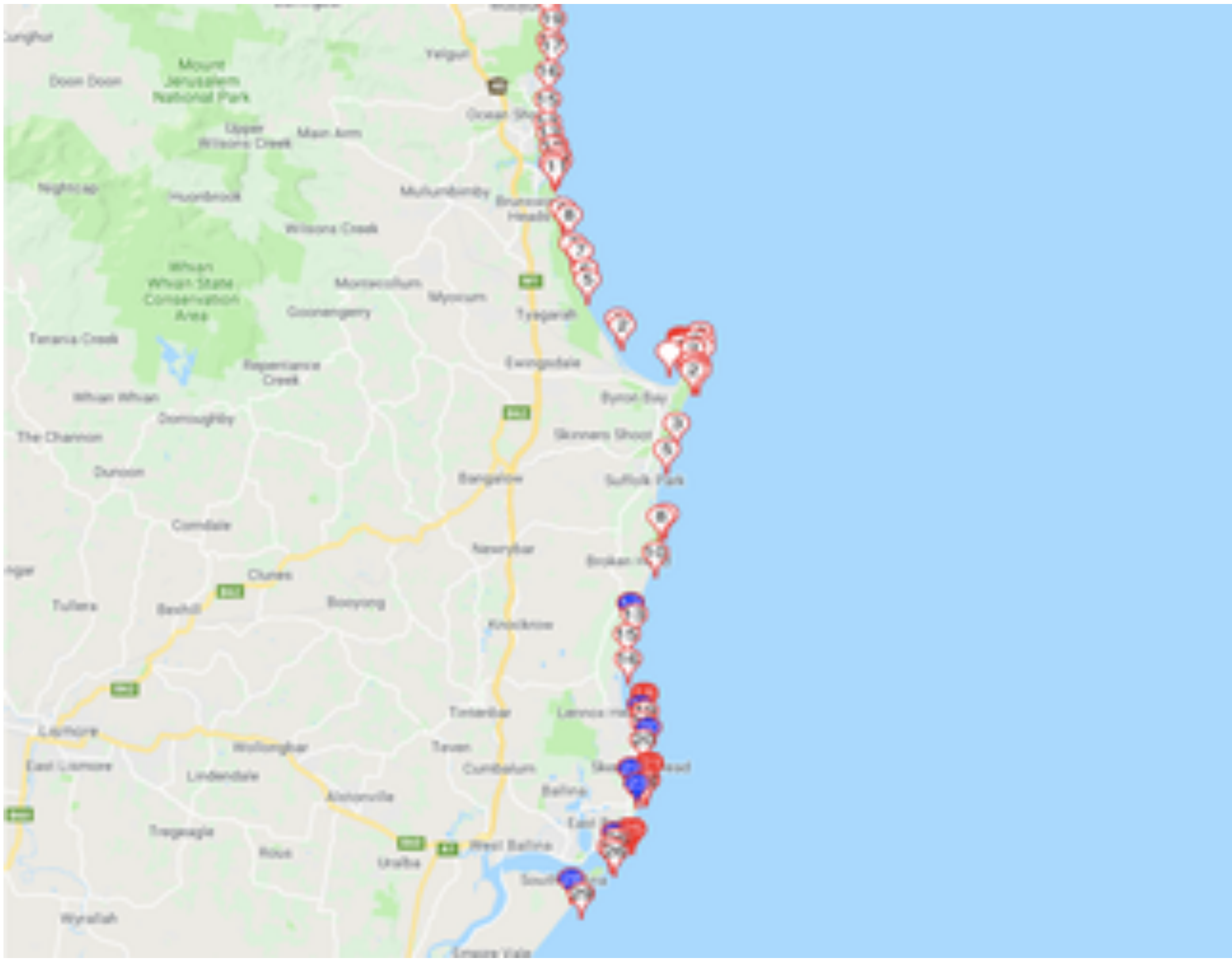
Results

The research and development phase has been completed, and a design for field testable prototypes has been finalised, and the initial field test prototype constructed for testing. This is a fully functioning Shark Smart Alert System in a portable form factor. Research and investigation into the software and hardware systems for the prototype phase is complete and all final elements for the device have been determined, this includes a fully functional logic and communications system, with a field testable solar power system, all in a portable enclosure. We've used a completely modular approach, using readily available and easily replaceable off-the-shelf components for the three major subsystems: logic/processing (build on the Mobiconnect IoT platform), solar power & battery storage, and internet communications.

We've been through a few iterations of alpha and beta test prototypes, and we've got some preliminary data on the solar and battery requirements from these prototypes with extensive data logging that's been installed up on the roof for 6 weeks or so. The power system components used for prototype #1 (10AHr battery and 2 x 10W Solar panels) last through around three days of bad weather, and can top the battery off with just one good sunny day. More field testing needs to be done to verify these measurements in real world conditions (several factors will affect these parameters, such as 3/4G signal strength at the site, solar panel placement and shading, battery ambient temperature variations, etc).

This revision of the software allows each device to have a list of lat/long pairs with a distance - so the detection area can be made up of as many overlapping circles of different radiuses as needed. On advice from DPI and SLSA shark experts, we've configured the prototype to alert a 1km radiuses around the deployment location, and to remain in alert state for 1 hour after the most recent alert detection. These settings as well as the device location are remotely configurable for each device, so can be updated without needing to physically access the device.

This map shows the alerts so far for 2018 in the Byron Bay region -the white markers are helicopter sightings, the blue markers are Smart Drumlines, and the red markers are VR4G detections (note the VR4G detections are the most common by far - they're a bit hidden here because they all pile up on top of each other, so even though there are many many more VR4G detections, the helicopter sightings stand out more - perhaps misleadingly).



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Discussion and feedback

Discussion and comments from workshop on 18th **June 2018** at the Mobiddiction Sydney offices.

Attendees:

Byron Shire Council: Michael Matthews
DPI-NSW: Marcel Green, Vic Peddemors
SLSA: Matt Du Plessis
RMS: Rod McDonagh
Mobiddiction: Mike Vasavada, Iain Chalmers, Hamsa Chandrappa and Diana Rao

There have been previous discussions with Byron Shire Shire Council about whether the most useful location for the devices might be on the beach - intended to be seen by swimmers or surfers while in the water, or perhaps at carpark entrances or at the walkways from the carpark to the beach. Vic pointed out the by far the majority of shark attacks happen to surfers compared to all other beach users, and concentrating testing and production deployment at prime surfing locations will provide most benefit - and for Byron Shire this means Wategos, Tallows, and Main Beach will be the most important sites. Deploying at non patrolled surfing sites will likely provide the largest safety benefit, followed by sites that are patrolled but where the patrols do not cover the popular dawn/dusk surfing times.

Rod from RMS agreed that for the prototypes using automotive tail light type alert lamps and for the 3 test locations identified (Wategos, Tallows, and Main Beach) there wouldn't be any problem displaying red lights for shark alerts. This advice might change if brighter lamps are used in future versions and will be site-specific. There are a few locations in NSW where there are important daytime navigation marks using lights, and collaboration with RMS will be necessary when choosing future deployment sites.

Surf Life Saving Australia have a project under way with a significantly shared solution, they currently have mobile rechargeable beach danger warning beacons - but are planning to instead use permanently installed pylons (similar to the SAD plan). Working SLSA them to deploy our technology and ideas alongside theirs, and vice versa, will be a great idea.

SLSA have and use the SharkSmart data from their central ops center in Belrose, and have comms to all surf clubs via which they push that data out to individual beaches. SLSA also consider other beach hazards beside sharks (and dangerous marine life) which the SharkSmart program does not consider (such as dangerous rips or pollution) -

We've aimed for the "simplest possible interface" as our best solution to the "shark detection warning" - but Marcel and Matt noted that a more generic "beach safety pole" would have an Australia wide appeal - which could not only increase the total number of installations (reducing the unit costs via volume production) but would also open the project to federal sources of funding.

It was pointed out that often the best sites for in-surf visible beacons/lamps are locations managed by other parties - this may require careful negotiation and collaboration to acquire needed permissions (on the positive side, sometimes these may result in locations with power and/or internet available, which can simplify and reduce the cost of an SAD that does not require solar/battery power or a 3/4G cellular modem.)

Vic Peddemors, Head of NSW Shark Research has advised that white pointers are capable of speeds around 40kmh, so can cover 1km in little over a minute, but that's exceptional and data shows that typically sharks tend to travel as only a few kmh. This has lead to a "rule of thumb" in the shark detection alerting space of using a 1km radius as the alerting area. It was noted that the VR4G technology detects tagged sharks out to approximately 700m, and are typically deployed ~700m from the beach to maximise coverage, and since they are non-directional this means they'll alert on a shark up to 1.4km offshore.

Matt du Plessis, Lifesaving Manager, advised that from his time in WA, they were keeping alerts active for 1 hour after a shark detection, and Vic agreed this was a reasonable figure based on incident experience and known shark behaviour.

The system currently uses exclusively DPI SharkSmart app alert data, but any internet-available alert or danger data source can be incorporated. In the event that DPI data stops being available other data sources such as local spotter or drone operators, Dorsal, Argos, or any other shark sighting data can be utilised instead. We've used the DPI data as it's the highest quality of actionable shark alerts available, with the DPI Shark science team making determinations about beach user risk from detections and filtering out non-shark and non-dangerous shark detections.

Recommendations

Mobiddiction recommends that we get the first prototype out in the field, and start collecting feedback from people seeing it in action.

The lamp used on prototype 1 is a waterproof boat trailer tail light assembly. The requirements for the lamp used in the phase 2 production design will be determined based on surfers ability to see the alert light from out at the break at typical surf locations. The distance the 1st prototype's lamp can be discriminated should be evaluated in various visibility conditions, and possibly a different lamp or multiple lamps trialled on the prototype. A more powerful lamp will have both solar/battery power implications, as well as potentially needing to liaise with RMS about ensuring it doesn't interfere with marine navigation lights.

It may be useful to trial using a backboard behind the light - since especially at distance the light will be difficult to find when it's off - and a backboard behind the light of black or white might make a significant difference in surfer's ability to find the light and determine it's on the "off"state.

Initial research shows that a 500m visibility distance would comfortably cover a significant portion of Tallows Beach - see map/diagram:

Conservation Area
Cape Byron
Cape Byron
Tallow Beach Car Park
Tallows Beach

Byron Shire Council should advise test locations and plans - these should include: lamp distance visibility measurements in a range of ambient light and visibility conditions, ability for surfers to locate the device from the water (particularly can they see and determine if the light is off), the device runtime under various weather/solar conditions, potentially retesting with additional or different lights.

A webpage should be set up as a description to the public of what the device is for and how it works, and the url and a QR code linking to that webpage should be affixed to the device. (We can host this on the Mobiddiction website if that's the quick/easy way to get that done. The deed gives DPI publishing rights so they might want to host that page, it's a Byron Shire Council project, so perhaps they would want to host that informational page.)

We've considered many different behaviours of the alert lamp - flashing or multi colour lamps are possible, but we chose to keep to the simplest and easiest to explain interface of just a lamp that turns on when a shark is detected nearby. Anything more complex would require some explanation of what each behaviour or colour means, which is hard to communicate and open to interpretation in ways that the simple "if the light is on, there's sharks about" approach.

We should investigate two avenues to deploy this technology - as the original idea of stand-alone Shark Alert Devices deployable at surfing locations as un-patrolled beaches or beaches which are not always patrolled at relevant surfing times, as well as collaborating with SLSA to potentially deploy Shark Alert technology onto their new fixed beach safety beacons and/or at surf club premises.

Using light requirement determinations from prototype testing, final sizing of solar panels and battery can be made, and investigation into commercially available enclosures can commence (asking Rod from RMS about who manufactures the solar powered school crossing systems would be a good start here).

In preparation to seek funding for phase 2, Byron Council with support from Mobiddiction, will provide active demonstrations of the Prototype to Local Surf clubs, neighbouring Councils, local SLS and with the permission from DPI, to stakeholders that attend the North Coast Shark Management Strategy Meeting. Feedback from these sessions is to be presented in future grant applications, in order to secure necessary funding required to progress the Proof of Concept Phase 1 to Phase 2 production. Upon approval of Phase 2 Mobiddiction will recommend budget and timings. DPI-NSW & Byron Shire Council to advise.

References

1. Device/software logic overview
2. Electronics design
3. Parts and links
4. Mobiddiction
5. Raspberry Pi & Raspbian Linux
6. Arduino

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