

ReefGrid - QPSF Sensor Networks Project: Summary, Goals, Budget
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Background & Introduction

This project, which started in 2004, is a collaboration between QPSF¹, AIMS², JCU³ and UQ⁴ to deploy a long-range sensor network for remote reef monitoring. It represents the first steps towards the development of a substantial, long-range environmental sensor network for regular on-line monitoring of marine eco-systems in tropical regions of the world - *ReefGrid*. This initial program in north Queensland will be the first such production-quality system in the world and could become a model implementation of remote reef and marine monitoring that will place QPSF and its partners at the forefront of this high impact area. The project is a direct complement with several of the Queensland Government priority research areas, especially understanding and sustaining our tropical environment.

This is a large scale, long-term, multi-disciplinary project that spans marine and ecological sciences, engineering and communications, software and information sciences management as well as physical and computer based modelling, all bound within an e-Research framework. While the project is complex, the partner organizations contain considerable experience in each of the individual components. QPSF plays a critical role in providing seed funding for the project, providing access to back-end HPC resources and embedding the activity in an e-Research framework.

The project builds on considerable prior development work by the participants. In late 2004 a successful trial was conducted of long-range, over water microwave communications: from the AIMS weather station at Davies Reef (78km offshore, east of Townsville) to the shoreline adjacent to AIMS. These successful trials demonstrated the viability of long-range, low power microwave communications across 'humidity ducts' in tropical oceans. They provide confidence that we can deploy the essential wireless link between remote marine sensors and land-based optical fibre networks.

The partners now are building on those trials to deploy a permanent communications link (of between 1-20 Mbps capacity) to the new Davies Reef weather station, and use this platform and link as the 'base station' to deploy a wireless network of multiple sensors across this reef. The data will be streamed to shore, archived in QPSF facilities and available for research, outreach and promotional activities via the Internet. In particular we are planning to enable streaming of live video data from the remote reef site – a world first.

Benefits to Australia and the State of Queensland: aside from the scientific and natural resource management outcomes - include the development on local 'know-how' in developing and deploying long-range, stand alone sensor networks that are of growing importance, particularly for our neighbours in the tropics. This will have the

¹ Queensland Parallel Supercomputing Foundation Ltd. (an APAC partner) www.qpsf.edu.au

² Australian Institute of Marine Science www.aims.gov.au

³ James Cook University www.jcu.edu.au/hpcu

⁴ University of Queensland www.vislab.uq.edu.au & www.cms.uq.edu.au

capacity to increase the National and International opportunities for Queensland's ICT and engineering consulting sectors.

A *ReefGrid* wiki and mail-list have been established⁵.

Project Plan, Goals and Objectives

The project has four stages, detailed below, each of which is expected to take about 6 months to implement, with an overall project duration of 2 years. At this time only stage one is fully costed and funded. Successive stages are likely to be more expensive. Stages 1-3 will instrument Davies Reef, while Stage 4 will extend the network to Myrmidon reef, Orpheus Is and Magnetic Island and Heron Is. This final phase, while simpler as it builds on the previous stages, is likely to be more expensive.

Phase 1. Short-term goals (Sep 2005-Feb 2006) - operational communications to Davies Reef with basic sensor packages deployed.

- New weather station tower (15 m height) positioned on Davies Reef⁶ with two 'floors' (~3m²) available to the Sensor Networks Project (installed Oct 2005) – the old tower is shown at right.
- Purchase and installation of *emSolutions* 10.5GHz microwave link on Davies platform and AIMS pump house, establishment of link. (Oct 2005)
- Purchase and installation of necessary hybrid power sources (solar and wind) in order to power the remote communications and sensor hardware.
- Have operational middleware software/hardware (CIMA, SRB sput, camera and power management operational and installed on WinSys VIA pc104 stand-alone PC board) installed on Davies site.
- Installed and operational PTZ web cameras and temperature sensors – data globally available on the web
- Launch event in early 2006



Davies Weather station

Phase 2. Medium term goal (Mar 2006 – Sept 2006) - Pilot short range sensor mesh on Davies established.

- 802.11x wireless network mesh established on Davies Reef for remote sensor interconnection
- Ad-hoc network in place and power management sufficient for 30 days unattended data delivery.
- Pilot the use of motes (Paul Havinga, Univ dr Twente, Netherlands)

⁵ <http://ihpc.jcu.edu.au:8080/Reef%20Grid-Sensor%20Networks/FrontPage>

(note this site is in redevelopment and conversion to a more flexible plone based wiki).

⁶ <http://www.aims.gov.au/pages/facilities/weather-stations/davies.html>

- Pilot of locally developed medium range-low power sensor platforms (Keith Kikkert, EE JCU)
- Development of further low-power instrumentation (Peter Ridd)
- Initial demonstration at Pragma-10 meeting (March 2006)

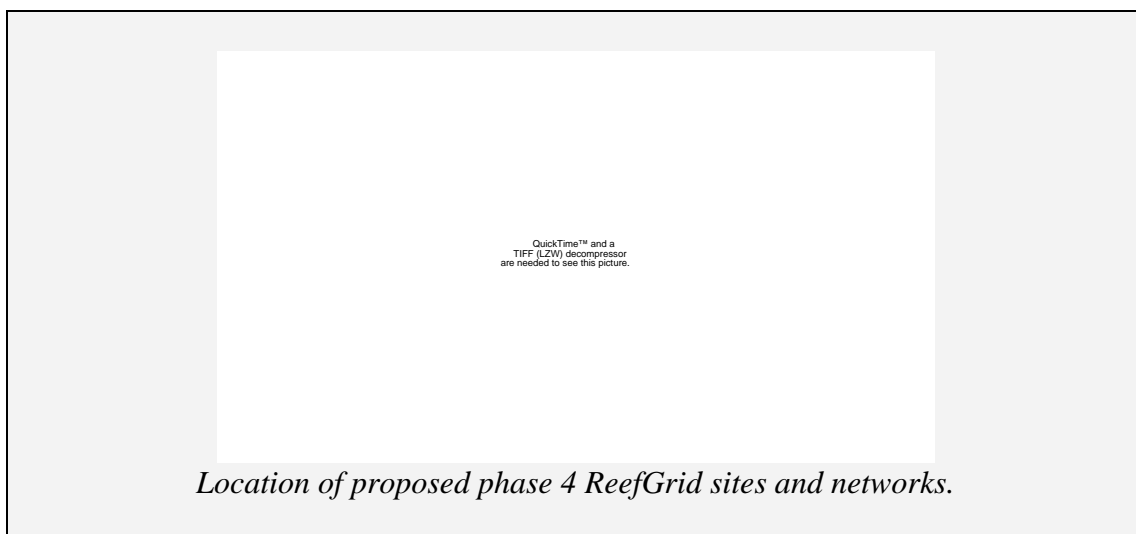
Phase 3 Long term goals (Sept 2006 – Feb 2007)

Highline goals: Long range sensor mesh on Davies established.

- Deployment of complete sensor mesh (estimated to be 30 remote sensors) across Davies Reef site.
- Deployment of sensor mesh across Heron Is. site (CMS@uq).
- Data storage standards and metadata curation issues resolved, in collaboration with the DART project.
- e-Research 'data grid' middleware infrastructure in place and operational
- System in routine operation and being used 'live' for ecological research

Phase 4 Ultimate goal (2007)

- *Inter-reef mesh of long-range communications networks with multiple paths.*
- *Major coverage of reefs with diverse sensor packages,*
- *Data stream from sensors integrate into holistic e-Research storage systems (AIMS, JCU & UQ/QPSF) and workflow environments*



Project Participants (Phase 1 only):

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|-------|--|
| AIMS: | Stuart Kininmonth (GIS Manager)
Scott Bainbridge (IT Manager)
Eric Brinkman (Workshop Manager) |
| UQ: | Bernard Pailthorpe (QPSF)
Nicole Bordes (metadata, GIS and visualisation)
David Gwynne (SRB support) |
| JCU: | Ian Atkinson (IT)
Graham Woods (Electrical Engineering)
Chris Palazzi (MEng Student, EE)
Gilles Gigan (PhD Student, IT)
Peter Ridd (Physics) |

Project Budget for Phase 1 is ~\$100k, for power, communications and sensor equipment deployment, weather proof enclosures, AIMS workshop support and boat time – see estimated Budget, below. For Phase 1 it is proposed that QPSF and AIMS + JCU jointly share the costs. Follow-on funding is anticipated under the NCRIS program and ancillary grants, as exemplified below.

Related Activities and Collaborations:

ReefGrid is an iconic project, and is acting as an attractor for a wide range of supporting and related projects and funding streams; a selection of which include:

- ARC Sensor Networks Research Network – DEST: International Science Linkages Grant (led by Palaini, U. Melbourne) ~ \$400k pa, 3 yrs.
- Ecological wireless sensor networks for environmental science and community engagement (Paul Havinga, Univ of Twente, Netherlands) – €3M proposal to EU VI-th Framework Program.
- ARC Linkage (O. Hoegh-Guldberg & S. Kininmonth, Heron Is; Coral Bleaching) - \$20,000 pa
- DEST ARIIC program – DART project for data support (led by Monash, with Pailthorpe and Atkinson) - \$3.247M
- NSF Middleware award: CIMA, R McMullen (Indiana, ANL, UCB) ~ US2m.
- ARC Linkage (with M. Heron, JCU and O. Hoegh-Guldberg, UQ) – Installation of Heron Is. Codar Radar
- ARC e-Research projects (Pailthorpe, Vislab@UQ & co-workers) – 4 x ~ \$70k
- ARC LIEF award for 2006, for data storage infrastructure (Pailthorpe, with Monash, ANU & JCU) - \$800k (ARC) + \$690k (matching cash)
- Host site for multi-national “PRAGMA-10” and “Lakes and Coral Reefs -3” meetings in Townsville in March 2006.

Project Budget estimate – ReefGrid Phase 1 Only

Item	Description	
Microwave Equipment	EM Solutions - 10.5 Ghz system	\$26,000
Remote Power	Solar System	\$3,500
	Wind Turbines	\$3,000
	Regulators	\$1,000
	Deep cycle batteries (48 V)	\$1,000
Weather proof equipment enclosures		\$5,000
Electronics	Micro SBC systems	\$2,200
	Switches (power / ethernet)	\$500
	Terminal server & misc. expenses	\$2,000
Software	Adobe flash presentation server	\$3,700
	Total	\$47,900
<i>In-Kind (est.)</i>		
Boat Time (2005/6)	AIMS	\$8,000
Workshop Support	AIMS	\$10,000
Onshore infrastructure, Fiber connections, Antenna installations, Power connections	AIMS	\$10,000
Antennas	JCU	\$1,500
Workshop Support	JCU	\$5,000
Sensors and Instruments	JCU	\$8,000
	Total	\$42,500