Wireless Challenges to Australia

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Wireless Technologies Laboratory
CSIRO ICT Centre

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Welcome to Australia!

- **Who are we?**
- What's special to Australia?
- Wireless Communications
- Wireless Sensor Networks
- What next?

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CSIRO and ICT Centre

www.ict.csiro.au

- **CSIRO – Commonwealth Scientific and Industrial Research Organisation**
  - **The Australian national research agency having**
    - **80 years of history**
    - **6,500 employees**
    - **Multidisciplinary kills (23 divisions with many joint horizontal programmes)**
- **CSIRO ICT Centre**
  - **Consisting of four Australian national laboratories**
    - **Wireless Technologies Laboratory**
    - **Networking Technologies Laboratory**
    - **Information Engineering Laboratory**
    - **Autonomous Systems Laboratory**
  - **Plus e-HRC**

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CSIRO ICT Centre

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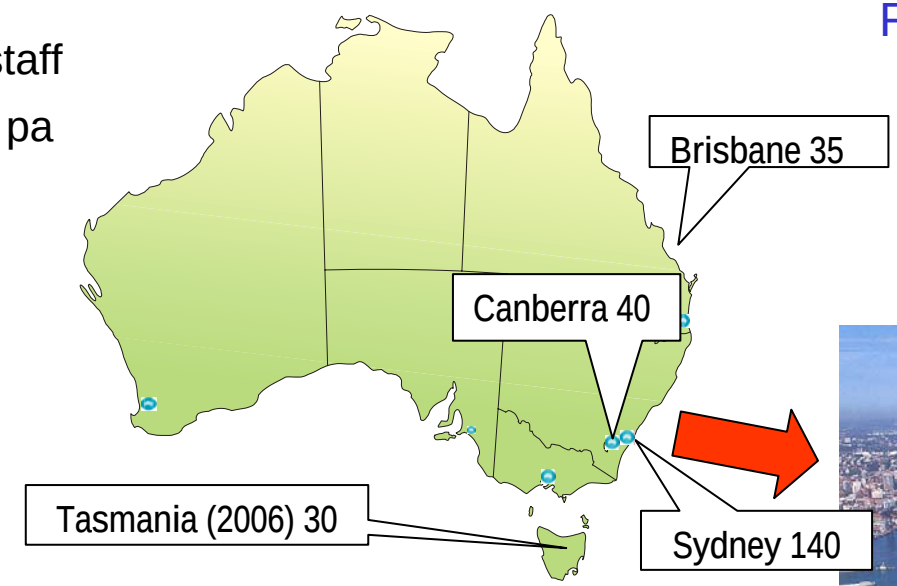
~250 staff

>50 M pa

Formed in September 2003



Sydney

Wireless Laboratory

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Wireless Technologies Laboratory

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- Largest Wireless Laboratory in Australia
  - Over 60 researchers specialised in antennas and propagation, RF design, signal processing and ad hoc networking
- Balanced Research Portfolio
  - Wireless communications
  - Wireless Sensor Networks
  - Multi-spectral Imaging
  - Antennas and Propagation

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Major Achievements of CSIRO in Wireless Communications

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- Developed an WLAN in (1992 – 2002) and our patent underpins the 802.11 standard in OFDM – used by the spin-off **Radiata**
- Supplied the 20/30 GHz (Ka-band) transponder for the FedSat satellite
- Invented VLF “through the rock” underground emergency communications system
- Gallium Arsenide chip manufacture technology was recently spun-off as **EpiTactix**
- Breakthrough in multi-beam antennas for satellite communications
- World-class MIMO technology demonstrator

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Our History of Achievements

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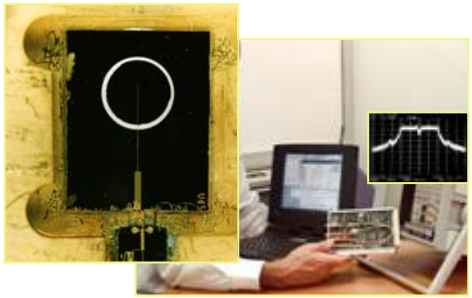
Interscan Microwave Landing System (1972-1982)

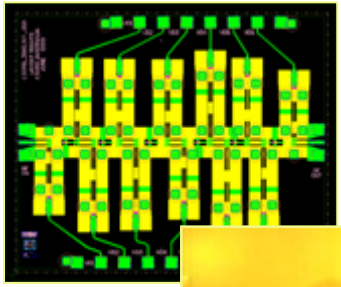
Mimix Broadband Radio and MMIC development (1992-2002)

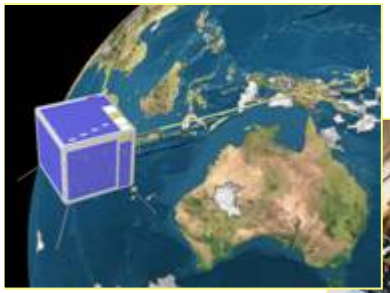
Australia Telescope (1983-88)

Emergency Mine Communications (1998-)



WLAN / mm-wave WLAN
***Led to Radiata* (1990-2001)**





Ka-band (30/20 GHz) transponder for FedSat satellite (1997-2002)

Antenna Systems (1980 -

GaAs MMIC fabrication and processes (1986-2001)
Led to EpiTactix

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Checklist

- Who are we?
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Unique Characteristics of Australia

- Most of the population is concentrated in a few large coastal cities. Much of central Australia is desert.
- Low density rural population (dwelling spacing ~5 – 10 km), and small towns (~500 - 5000 people) accounting for over about 5% of the land mass.
- Very long coast-line, the majority of which is very sparsely settled.
- Rich resources therefore strong mining industry
- Severe storm fronts, bushfires and droughts
- Australians are tech-savvy but not interested in sun& beach holiday video clips!

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Challenges to Australian Wireless R&D Community and Strategies

- **Major Challenges:**
  - Far away from the major international markets
  - No “home-grown” international heavy weight
- **Strategies of the R&D Community**
  - Collaborate with overseas major players and foster the growth of local industry
  - Leverage on our “local” advantage
    - Cost-effectively meeting local application requirements which differ significantly from those being satisfactorily addressed in other countries
    - Finding overseas market “niches” which are well matched to Australian capabilities – particularly in areas such as mining and agribusiness where local requirements have justified the R&D, so that overseas markets represent a bonus.

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Some Major Application Challenges

- Providing “fair” communications access to rural and isolated communities.
- Coastal surveillance to stop drug-trafficking, illegal emigrants, and terrorists.
- Environmental (farm field, bush & water) monitoring
- Wireless communications for mine automation and safety
- Productivity in agriculture

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Checklist

- Who are we?
- What's special to Australia?
- **Wireless Communications**
- Wireless Sensor Networks
- Underground Communications for Mines
- What Next?

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Reality and Solutions

- **Reality**
  - Wireless and wired broadband services are ubiquitous in **major cities**, but **convergence** in technology and services is barely in place
  - People living in rural areas feel discriminated
  - Sketchy coverage of mobile phone services in the bushes
- **Solutions**
  - Stronger will from the regulators
  - Technology must be location dependant, especially for backhaul, and 3G, WiMax, Satcom and HAP all have their places

CSIRO Rural WLAN Demonstrator

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Research on Wireless Communications at CSIRO

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- Future Broadband Communications
  - Adaptive MIMO
  - Gigabit wireless for backhaul
  - Multi-band antennas
  - Co-operative ad hoc networks
  - Propagation studies for both indoor and outdoor
- Satellite communications

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CSIRO MIMO Demonstrator

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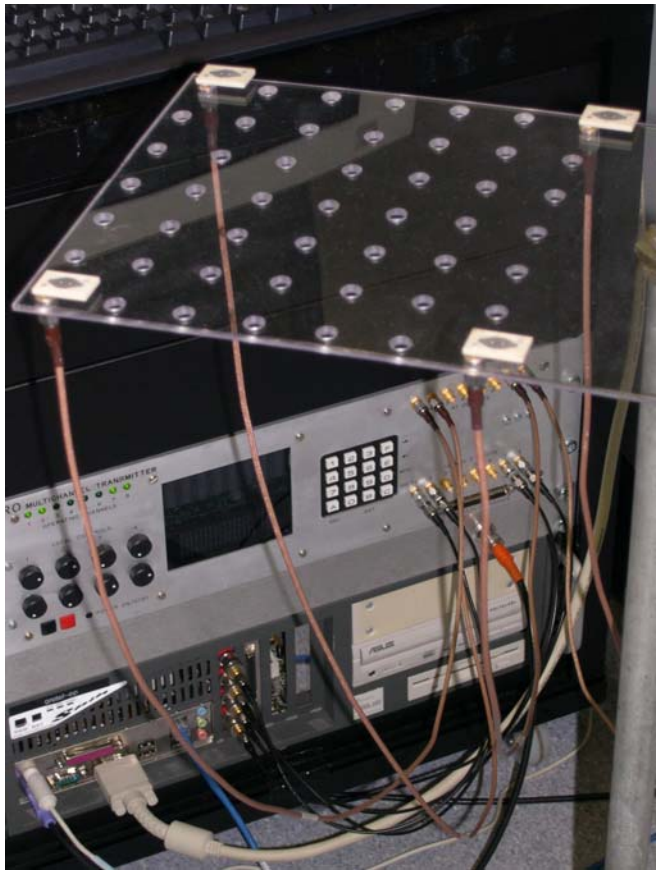

Current demonstrator supports 4 transmit and 4 receive antennas, OFDM, 64QAM and LPDC coding.

600Mbit/s data rate

Multi-user handling

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World-Class Antenna Technology

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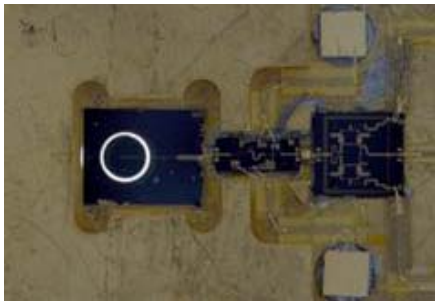
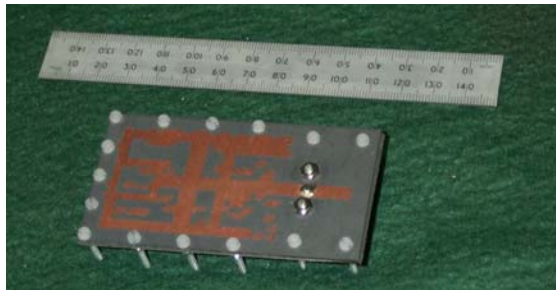
- Integral (patch/slot) antennas for mobile and wireless communications
- Broadband smart antennas
- Earth station antennas
- Feed systems
- On-board satellite antennas

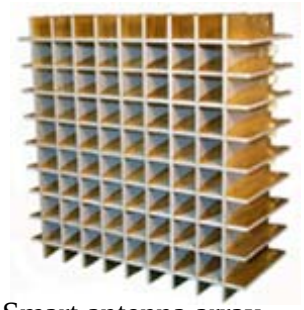


40GHz ring slot antenna integrated with GaAs LNA

Bunny-ear antenna (5:1 bandwidth)



5GHz WLAN antenna designed by particle swarm



Smart antenna array

Multi-band and multi-beam antenna

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Checklist

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- **Wireless Sensor Networks**
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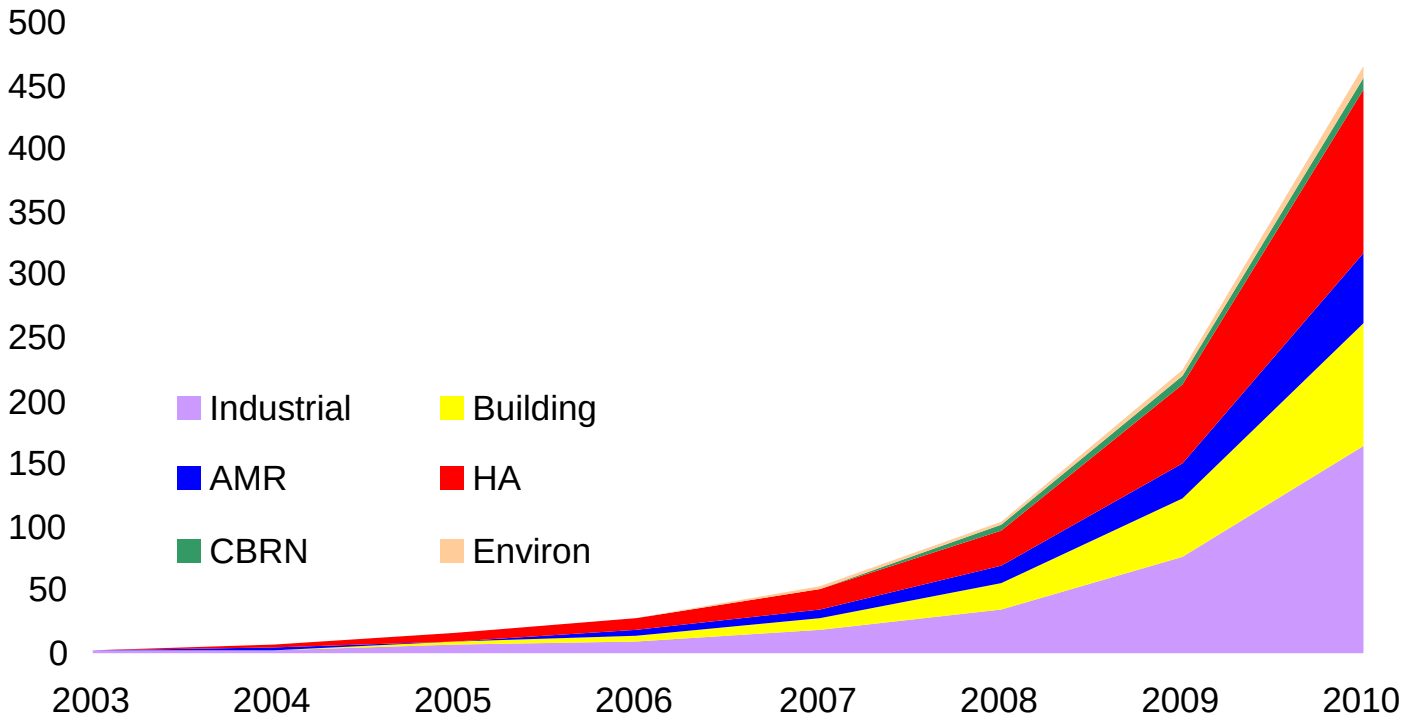
Wireless Sensor Networks Applications

- Industrial Monitoring and Control
- Commercial Buildings and Home Automation & Security
- Automated Meter Reading & Energy Management
- Environment and Agriculture
  - Irrigation control, animal monitoring & control
- Defence and Homeland Security
  - Biohazard detection, personnel & equipment monitoring
- Structural Health Monitoring
  - Strain & vibration in bridges, aircraft, ships, …
- Mining
  - Environmental monitoring and safety
- ……..

Does It Look Familiar?

Global RF Modules for Wireless Sensor Applications 2003-2010



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Extracted from Wireless Sensor Networks: Mass Market Opportunities

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Wireless Sensor Networks: Our Focus

- Port security
- Water resource and salinity monitoring /control
- Bushfire detection and control (particularly in isolated areas)
- Monitoring (and control) of grazing animals and resources in high and low density grazing environments
- Monitoring and control of off-shore natural gas production facilities
- Assistance in development and operation of mining projects (coal, iron-ore, uranium etc.)
- Sports (car racing, horse racing,..)

WSN: Major Challenges to Us

- Low data-rate, short range and medium size WSNs have been readily available using standard radio chips and protocols (ZigBee, WLAN)
- The challenges are in the following areas
  - **Long range** and **complicated** or **hostile environments**
  - WSN requiring **high precision position location** where GPS cannot be used
  - WSN with special requirements such as **high reliability, security or critical timing**
  - Very **large** networks

Farming 2020

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Positioning and Sensing Network: Car Racing

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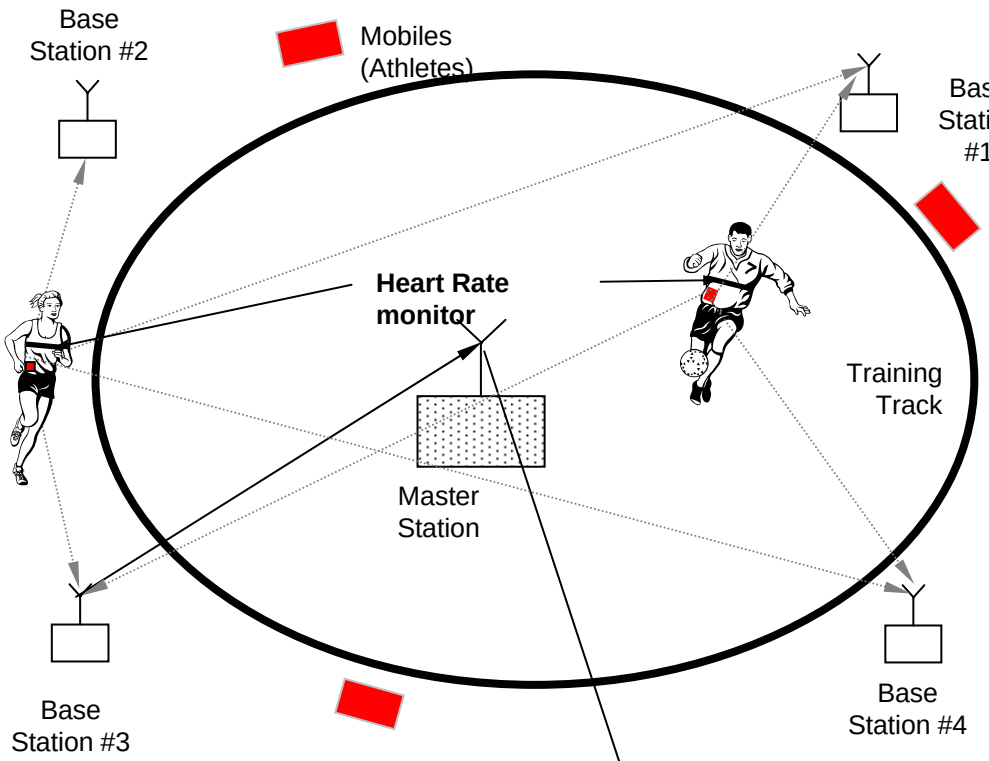

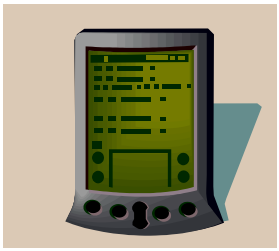

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Positioning and Sensing Network: Horse Racing

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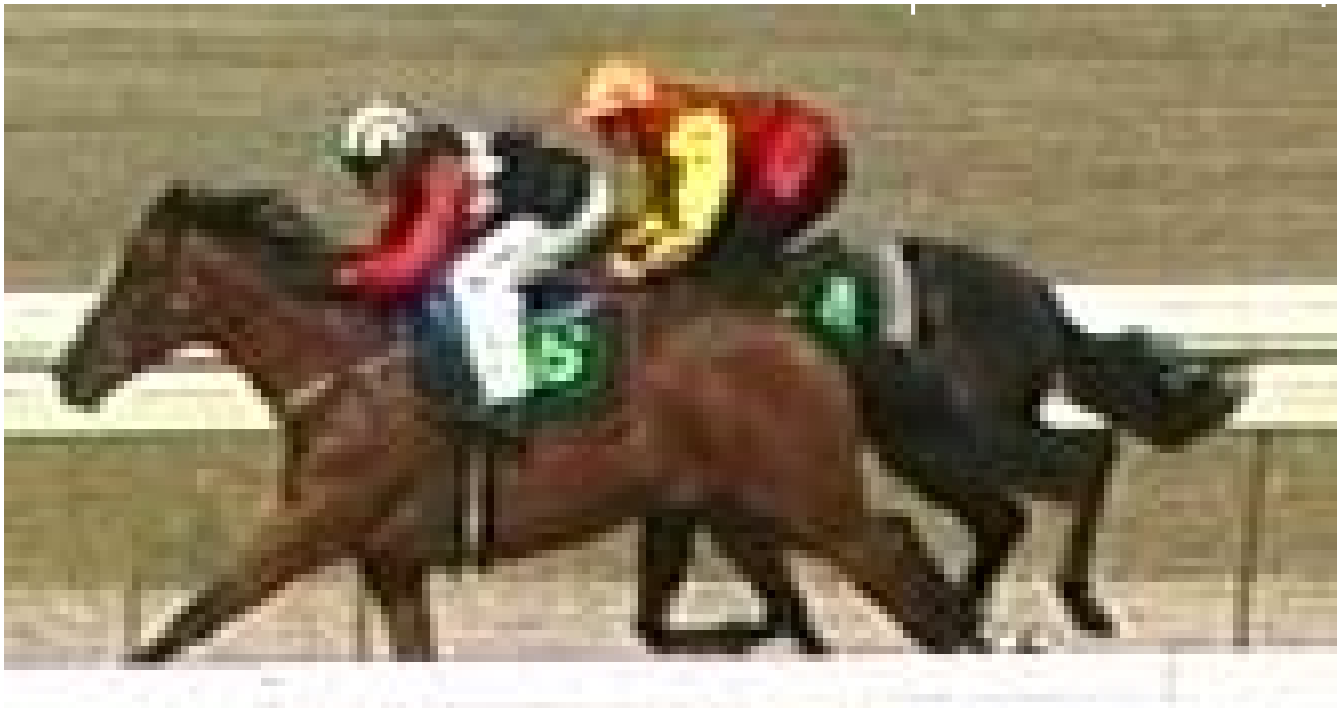
race starts at the 37
second point and ends at
the 97 second point.

Stride rate (derived from accelerometer), speed and position, heart rates of the hockeies



What Next?

- Collaboration
- Opportunities of working for CSIRO
  - Prominent scholars who'd like to establish a group or take an existing group to Australia
  - Established researchers
  - Postdocs
  - High-calibre engineers
- If you don't like the beach and metropolitan life in Sydney, we can host you in the peaceful and tranquil Tasmania!

Thank you very much.
Enjoy the conference!

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