

Wireless Challenges to Australia

Y Jay Guo

Wireless Technologies Laboratory
CSIRO ICT Centre

Welcome to Australia!

www.ict.csiro.au

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

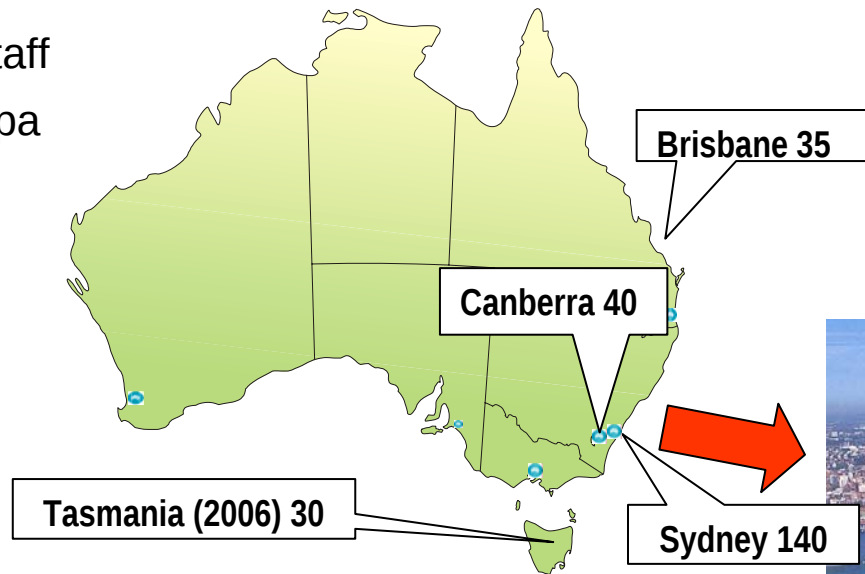
- **CSIRO – Commonwealth Scientific and Industrial Research Organisation**
 - The Australian national research agency having
 - 80 years of history
 - 6,500 employees
 - Multidisciplinary skills (23 divisions with many joint horizontal programmes)
- **CSIRO ICT Centre**
 - Consisting of four Australian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

CSIRO ICT Centre

www.ict.csiro.au

~250 staff
>50 M pa

Formed in September 2003



Sydney



Wireless Laboratory

Wireless Technologies Laboratory

www.ict.csiro.au

- 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

Major Achievements of CSIRO in Wireless Communications

www.ict.csiro.au

- 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

Our History of Achievements

www.ict.csiro.au



Interscan Microwave Landing System (1972-1982)

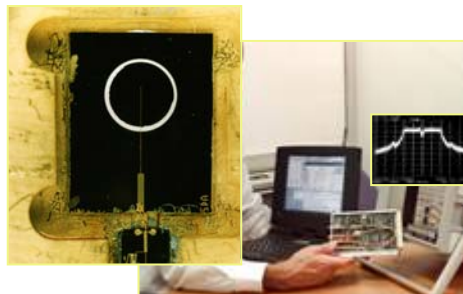
Mimix Broadband Radio and MMIC development (1992-2002)



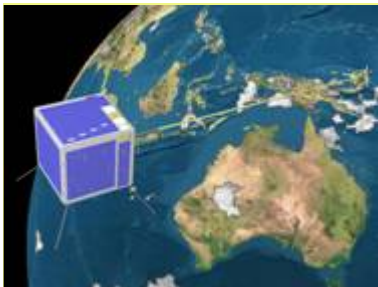
Australia Telescope (1983-88)



Emergency Mine Communications (1998-)



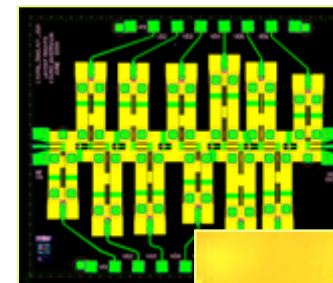
WLAN / mm-wave WLAN Led to Radiata (1990-2001)



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



Antenna Systems (1980 -)



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



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

Unique Characteristics of Australia

www.ict.csiro.au

- 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!

Challenges to Australian Wireless R&D Community and Strategies

www.ict.csiro.au

- **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.

Some Major Application Challenges

www.ict.csiro.au

- 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

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

Reality and Solutions

www.ict.csiro.au

- **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**

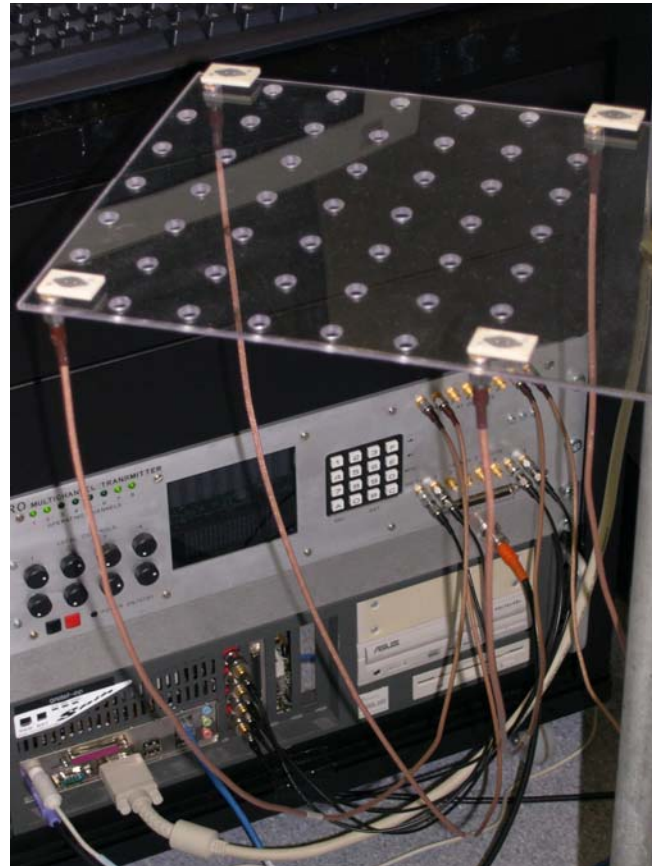
Research on Wireless Communications at CSIRO

www.ict.csiro.au

- 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

CSIRO MIMO Demonstrator

www.ict.csiro.au



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

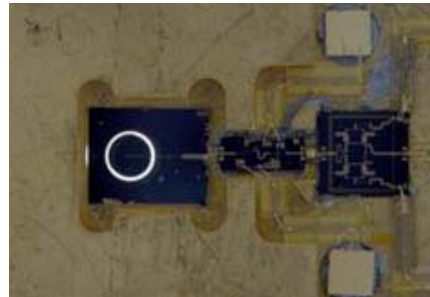
600Mbit/s data rate

Multi-user handling

World-Class Antenna Technology

www.ict.csiro.au

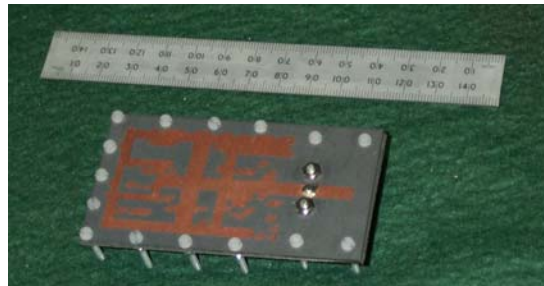
- Integral (patch/slot) antennas for mobile and wireless communications
- Broadband smart antennas
- Earth station antennas
- Feed systems
- On-board satellite antennas



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



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

Wireless Sensor Networks Applications

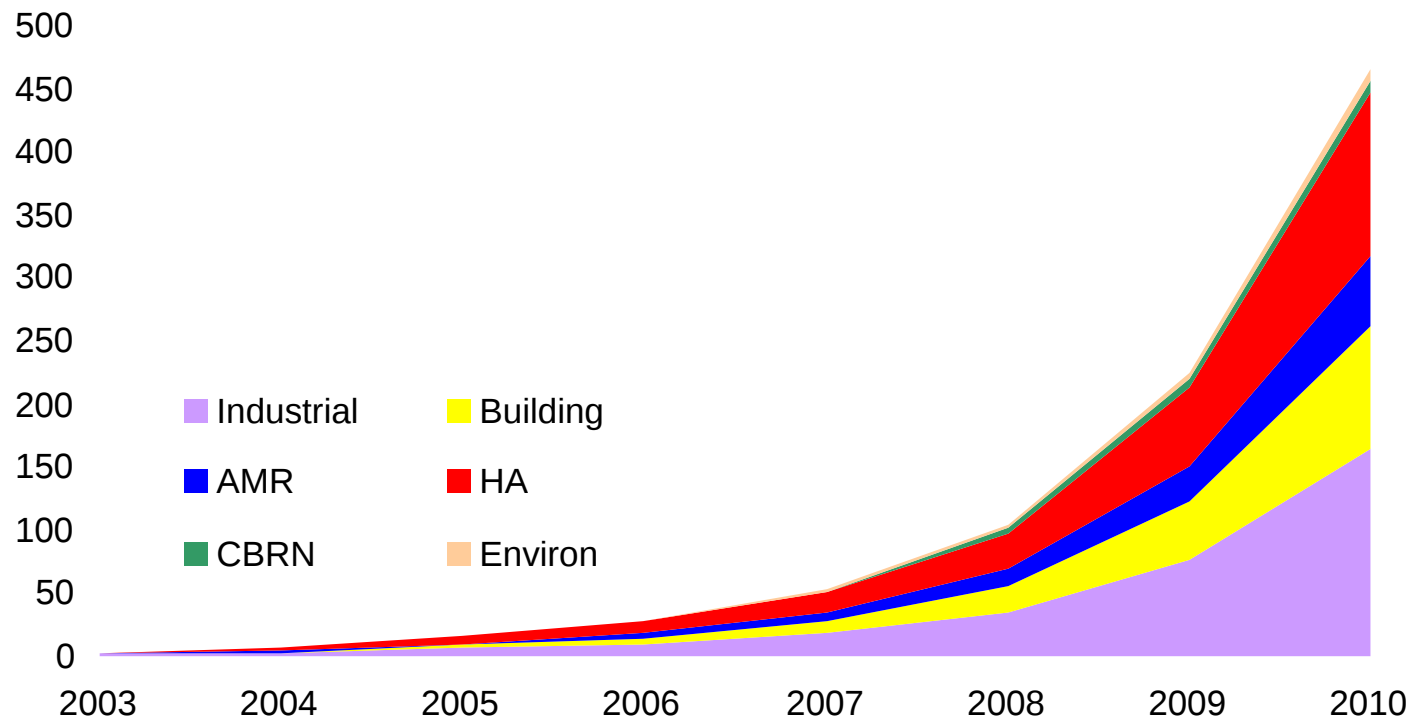
www.ict.csiro.au

- 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?

www.ict.csiro.au

Global RF Modules for Wireless Sensor Applications 2003-2010



© ON World

Extracted from Wireless Sensor Networks: Mass Market Opportunities

Wireless Sensor Networks: Our Focus

www.ict.csiro.au

- 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

www.ict.csiro.au

- 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

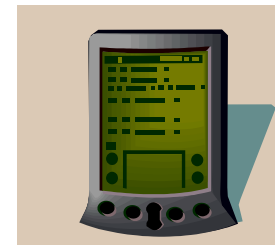
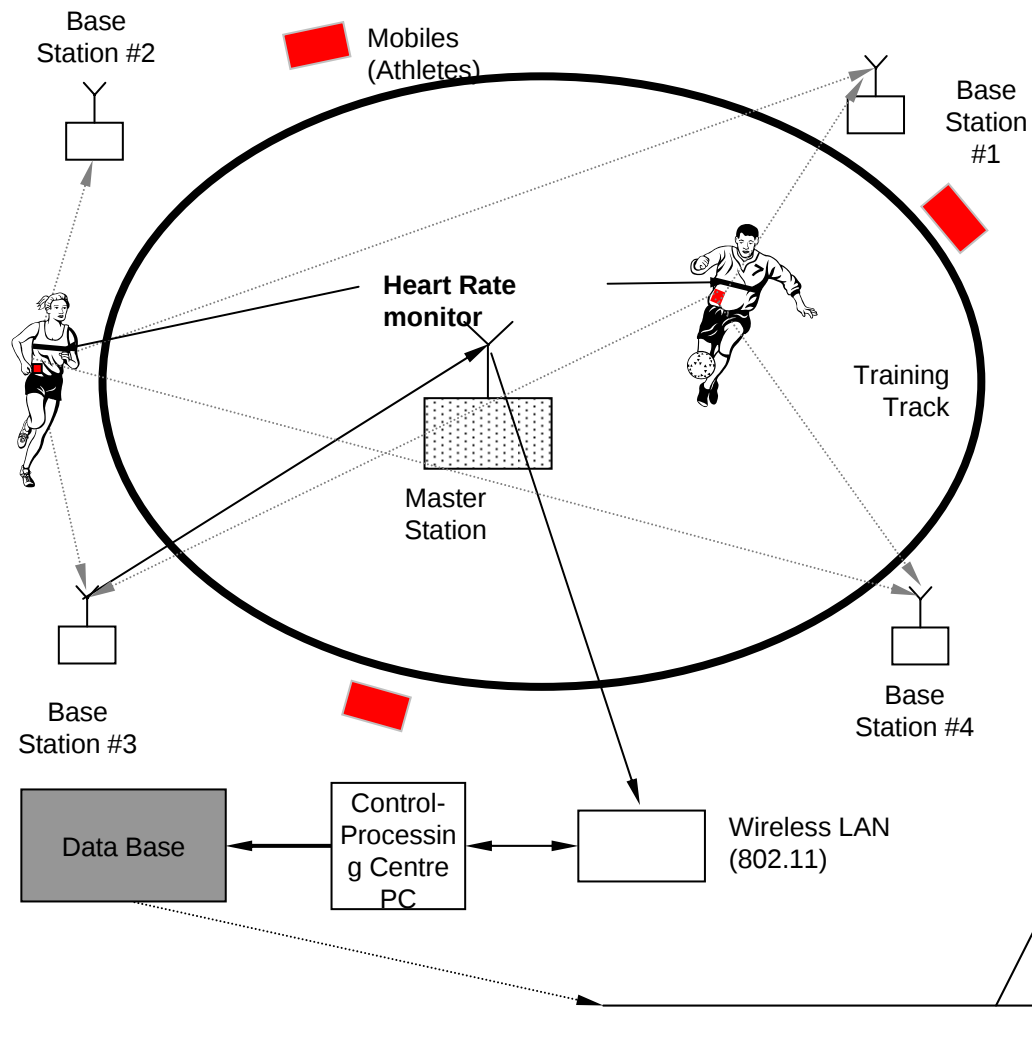
Farming 2020

www.ict.csiro.au



Positioning and Sensing Network: Car Racing

www.ict.csiro.au

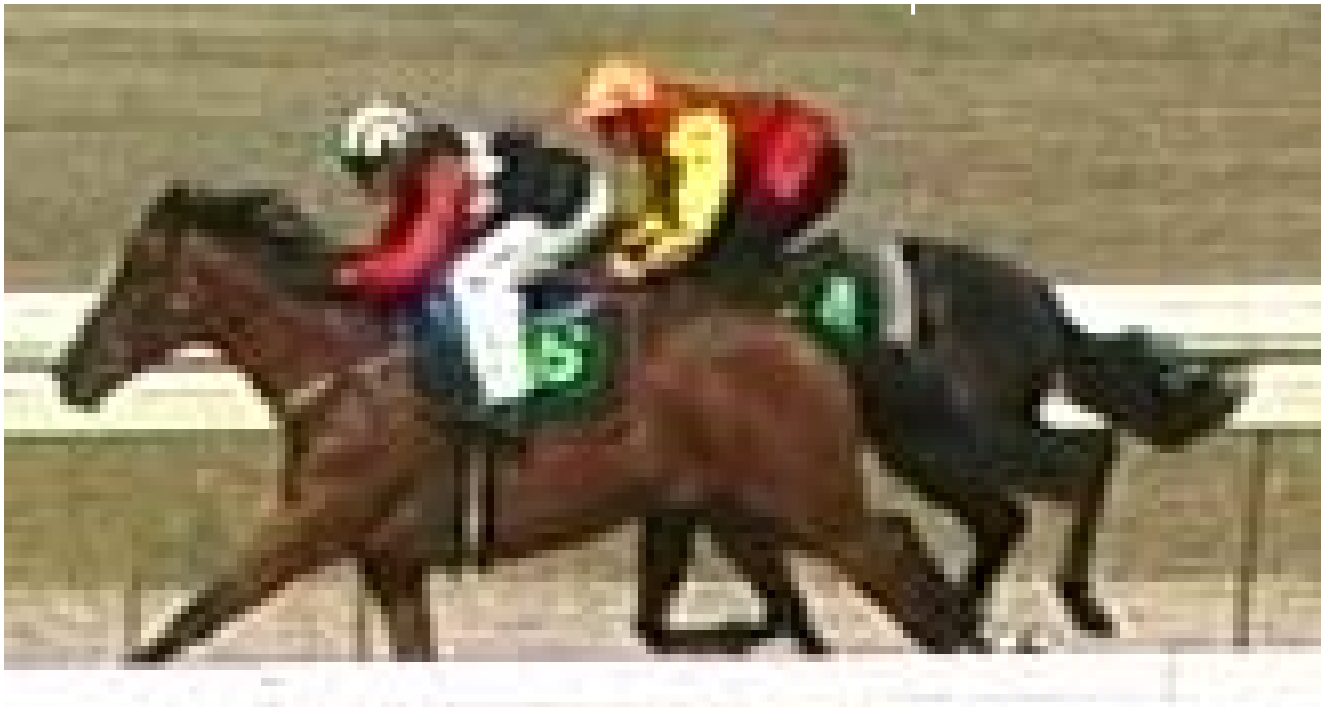


Positioning and Sensing Network: Horse Racing

www.ict.csiro.au

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?

www.ict.csiro.au

- 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!