

An Intelligent Infrastructure Initiative for Australian Society and Homeland Security

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As Australia readies itself to rebuild the nation's infrastructure to serve it through 2050, there exists a unique opportunity to leverage the great intellectual and technical capital of Australian universities and the private sector to create a 21st century digital "intelligent " civilian infrastructure, built on fiber optics, sensornets, and advanced information technologies.

To date the physical infrastructure of roads, bridges, levees, ports, and water transport systems is usually treated as a passive system that does not adapt, change, or interact with time. Repairs, emergency fixes, and upgrades are done only after the infrastructure breaks or becomes obsolete. Peak-period overloads are tolerated because the systems are fixed and changing usage is thought to be too complex. With this 20th-century approach we will always be in a reactionary mode, repairing or upgrading our infrastructure only when it no longer functions, e.g., when the gridlock on our freeways becomes utterly unbearable.

However, integrating an information infrastructure into our nation's physical infrastructure allows us to become proactive caretakers of the nation's critical infrastructure for commerce and homeland security. Publicly owned optical fiber enables distributed networked sensors and actuators to create an active synergy between the digital and physical infrastructure across Australia. Forward-looking countries are moving rapidly to this new paradigm—those that don't will be left behind.

"Intelligent infrastructure" systems use networked sensors to monitor the detailed health of physical structures and their environment, initiating maintenance and rehabilitation as warning signs develop, well prior to a crisis that may require the closing of the infrastructure for an extended time. Modular information technology devices with wired and wireless connectivity range from environmental sensors to remote steerable cameras, creating opportunities to observe local conditions and use this data to improve overall system performance. The persistence of these integrated sensornets allows for daily monitoring, while also enabling more intelligent response to natural emergencies or man-made disasters.

Potential application areas for Intelligent Infrastructure include:

Infrastructure Monitoring: Multi-use sensor systems integrated into civilian infrastructure would allow monitoring of the current level of functionality, as well as the status of the environment. Data from these systems would allow policy-makers to allocate resources more intelligently for maintenance and emergency repair

Transportation: Weigh-in-motion bridges that eliminate the need for truck scales can reduce obstacles to traffic flow on key transportation routes. Other sensors can monitor highway construction sites to eliminate casualties, and allow pre-emptive performance/condition-based maintenance that will minimize lane/highway closures. Data from this system can also be used for modeling the complexities of Australian traffic to improve flow and reduce environmental impact.

Education Revolution: Updated high-speed wireless internet can be deployed inside schools to enable "anywhere, anytime" educational experiences, coupled to external public sector fiber. This infrastructure architecture allows for periodic upgrades in broadband speeds to Australia's schools and classrooms. It is also imperative to ensure that a student and teacher PC and handheld technology is kept current as rapid innovation proceeds in the educational market.

Homeland Security: Persistent monitoring, with sensors and cameras, of "lifeline" transportation routes, sea and airports, and related infrastructure is vital for everyday commerce and essential for evacuation during disaster.

Given the great potential opportunities for Intelligent Infrastructure to impact the lives of Australians, I would suggest the following three recommendations:

- **Recommendation 1. A designated percentage of aggregate nation-building infrastructure investments should be allocated toward intelligence embedded in the physical infrastructure and mandated into the tender processes.** Such digital systems undergo the continual improvement that we see in the PC or internet sectors, making the physical infrastructure more valuable every year.

- **Recommendation 2. Another designated percentage of aggregate nation-building infrastructure investments should be devoted to the public research sector to drive innovations by basic and applied research on topics in intelligent infrastructure and its applications.** The source of innovation in intelligent infrastructure lies in the public research sector, including collaboration with best-of-breed international partners to assure the highest value research outcomes for Australia.

- **Recommendation 3. The research program should also competitively award industry/academic partnerships to create distributed geographic test beds to develop, deploy, and evaluate intelligent infrastructure prototypes.** This will allow research innovations to be evaluated in a real-world setting of "living laboratories," focusing on how intelligent infrastructure can lower total operating costs while improving services and public safety. The best testbed results would then be added into the build-out requirements of the nation's infrastructure.

This three-prong program will ensure that all physical infrastructure deployed will have embedded intelligence, which improves the performance of the infrastructure in a continual fashion. The nation's public research sector will be stimulated to apply their innovative talents to the problems of the nation's infrastructure. Finally, researchers will be able to test their innovations out in a rapid prototyping fashion, which will ensure that every year the embedded intelligence is more powerful than the year before.

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