Top Six Trends in Communications and Media Technologies, Applications and Services—Possible Implications

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## Contents

**EXECUTIVE SUMMARY** .................................................................................................................................................. 1

Overview—top six trends ............................................................................................................................................. 1

**TOP SIX TRENDS** ................................................................................................................................................... 3

1. Accelerating pace of change ........................................................................................................................................ 3
   1.1 Snapshot of the present .......................................................................................................................................... 3
   1.2 The longer-term view ............................................................................................................................................. 3

2. Diversity in physical infrastructure and higher-speed broadband networks ......................................................... 4
   2.1 Broadband .............................................................................................................................................................. 4
   2.2 Digital broadcasting ................................................................................................................................................ 5
   2.3 Smart radio systems—cognitive and software-defined radio .............................................................................. 5
   2.5 Sensor networks ....................................................................................................................................................... 6
   2.6 Mesh networks ........................................................................................................................................................ 7
   2.7 Efficiency techniques in multimedia transmission .............................................................................................. 8
   2.8 Location-sensing and context-aware technologies .............................................................................................. 8
   2.9 Intelligent Transport Systems technologies ...................................................................................................... 9
   2.10 Satellite services ..................................................................................................................................................... 9

3. Distributed connectivity ................................................................................................................................................. 10
   3.1 Computer networking technologies .................................................................................................................... 10
   3.2 IP-based services .................................................................................................................................................... 10

4. Emerging content and network management technologies ...................................................................................... 11
   4.1 Content monitoring technologies .......................................................................................................................... 11
   4.2 E-security ............................................................................................................................................................... 12
   4.3 Identity management ............................................................................................................................................... 13
   4.4 Access and management of digital content technologies .................................................................................. 13
   4.5 Energy efficiency applications ............................................................................................................................... 14

5. Web-based services and the emerging ‘social web’ ............................................................................................... 14
   5.1 Social networking sites (SNS) .............................................................................................................................. 15
   5.2 Mobile Web ............................................................................................................................................................ 15
   5.3 Internet TV ............................................................................................................................................................. 15
   5.4 Cloud computing .................................................................................................................................................... 15
   5.5 Virtual identities .................................................................................................................................................... 16
   5.6 Semantic Web ........................................................................................................................................................ 16

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Australian Communications and Media Authority  iii
6. Continuing scientific and technological innovation ................................................................. 17
6.1 Computing processor power .......................................................................................... 17
6.2 Display technologies ..................................................................................................... 17
6.3 Artificial Intelligence .................................................................................................... 18
6.4 Nanotechnology .......................................................................................................... 18
Executive summary

The Top Six Trends report was developed by ACMA to provide a concise overview of technology, applications and services trends over the next five to 10 years. It builds on earlier ACMA work undertaken in 2006 and identifies the potential impact these trends may have on ACMA’s functions and responsibilities. Trends are grouped into six overarching themes.

Overview—top six trends

1. An accelerating pace of change driven by overlapping developments in technology, and connections between people, databases and objects.

2. Diversity in the development of physical infrastructure including broadband, digital broadcasting, smart radio systems, sensor networks, mesh networks, efficiency techniques in multimedia transmission, location sensing and context-aware technologies, intelligent transport systems and satellite services.

3. Continuing spread of distributed connectivity through the integration of information processing beyond the desktop into everyday objects and activities.

4. Enhanced content and network management capabilities driven by developments in deep packet inspection and content filtering technologies, coupled with the need to improve e-security, identity management, intellectual property protection and energy efficiency.

5. The emerging social web acting both as a platform and database, enabling innovation and creativity by users and service providers.

6. Continuing scientific and technological innovation, which in combination are driving advances in computing power, display technologies, artificial intelligence and nanotechnology.

The business models of incumbent communications and media organisations are changing. Innovative new business models are providing alternatives in internationalised markets; that is, markets where firms—including small- and medium-sized firms—offer services in geographically distant markets through internet connectivity.

ACMA originally undertook an assessment of emerging technologies in April 2006. Many of the developments foreshadowed in that paper are now in the market. This fact highlights the increased need to continually review the appropriate focus for regulation. Key regulatory elements are being conceptually stretched and pulled. Allowing for the accelerating pace of change, a sustainable regulatory framework would need to provide for flexible approaches that are responsive to change and can accommodate new dynamics.
While this paper has a technology focus, the capacity for Australians to adopt and make effective use of these newer communications services and applications is dependent on the overall capabilities and skill levels of consumers and businesses.

The views set out here are not put forward as predictions; nor is this paper an attempt to pick technology winners or losers. It offers an opportunity to identify and engage with developments that affect regulation of the communications and media sector, and to anticipate the need for possible action.

Following an overview of each trend are short descriptions of the emerging technologies, applications and relevant services that are evident now, as well as those that may emerge over the next 10 years. A high-level outline of likely or possible regulatory implications is provided.

ACMA will continue to update emerging technology, applications and service trends on a regular basis, and we would welcome feedback on the paper.
Top six trends

1. Accelerating pace of change
Innovations in technology, services and use are being driven by digitisation, higher-speed broadband networks and diversity in physical infrastructure, distributed connectivity and the emerging social web.

1.1 SNAPSHOT OF THE PRESENT
Reflecting on changes that have occurred since 2006 highlights the sheer pace of change. Indicators of the trend towards pervasive computing are already evident in distributed, real-time data networks and networked high-resolution display screens, particularly in urban environments. Consumers are creating, re-using, remixing and distributing content one-to-many and one-to-one. When and where content is viewed can be shifted to suit personal preferences. News is captured in digital form and distributed by individuals—more or less in real time. The Social Web has enabled people to connect and communicate in new ways, driving new forms of social interaction and entrepreneurship. At the same time, identifying and meeting the needs of people who may lack the capacity or desire to access and use new forms of communications and media is an emerging social inclusion issue.

While large companies are likely to continue to dominate the provision of infrastructure and many communications and media services, their business models are changing. Niche players, third parties, networked collaborators, innovative business models and individual users are providing alternatives in internationalised markets.

1.2 THE LONGER-TERM VIEW
Overlapping developments in technology and increasing interconnections between people, databases and objects—which together enable innovation and creativity—are expected to accelerate change over the next 10 years and beyond.

Regulatory implications—pace of change
The indications are that key regulatory elements are being conceptually stretched and pulled, drawing into question the sustainability of current regulations. Issues about the appropriate focus for regulation include:

- determining, given the global reach and open nature of the internet, what role traditional regulation might play relative to international collaboration, self-regulation and consumer education;
- determining what role the term ‘any-to-any connectivity’ might have in five years time;
revisiting existing assumptions of ‘media diversity’ or ‘significance’—in terms of social and cultural objectives—in a world where almost anyone can become a de facto broadcaster or media celebrity;

- balancing openness (to promote inclusion, competition, collaboration and innovation) with closed systems (for high security); and

- defining regulatory responsibilities that reflect changing social expectations of user/producer content publication, and the control and use of personal data, privacy and security.

A sustainable regulatory framework needs to provide for flexible approaches that are responsive to change and can accommodate new dynamics. Regular and systematic scanning and analysis of developments and regulatory implications is necessary to maintain the relevance of regulatory practice. Scanning and research activity would need to link with research institutions and standardisation bodies in Australia and internationally. In the computing and internet community at least, much of this activity is being done collaboratively and online.

Content and platform convergence is creating current challenges for ACMA in regulating:

- content delivery over separate, stand-alone technologies;

- voice services delivered over IP networks; in particular, the application of ‘standard telephone service’ and ‘carriage service provider’ obligations to VoIP services; and

- special regulation for broadcasting services bands.

### 2. Diversity in physical infrastructure and higher-speed broadband networks

Developments in the diversity of physical infrastructure and broadband speed signal more choice, variety and increasing bandwidth. There are multiple distribution channels for professional content—mobile, IP-based, terrestrial and satellite broadcasting. Network access arrangements are likely to be a mix of open or shared access and closed systems. Advances in smart radio design and distributed connectivity is increasing the prevalence of wireless relative to wired access.

#### 2.1 BROADBAND

Broadband is a class of data transmission technologies, including optic-fibre (FTTx), xDSL (such as ADSL, ADSL2+ and VDSL), HCF cable and wireless (such as WiMax, HSDPA, LTE and iBurst), offering a data rate significantly higher than narrowband services.

Higher bandwidth is necessary to meet demand for increasingly data-rich and multimedia traffic that is increasingly two-way; that is, upstream and downstream. Wired local access data rates of up to 30 Mbit/s are available in some Australian urban areas. The highest average broadband speed internationally is currently in Japan, where optic-fibre deployment provides local access rates nearing 100 Mbit/s. In terms of wide-area networks, a new standard scalable beyond 10 Gbit/s using optic-fibre technology is under development. The deployment of multi-Gigabit data rates over optic-fibre networks in Australia is technically possible over the next 10 years.
The Australian Government is committed to delivering a national high-speed broadband network. Senator Conroy, Minister for Broadband, Communications and the Digital Economy, has announced plans for a national broadband network offering minimum download speeds of 12 Mbit/s to 98 per cent of Australian homes and businesses.

An Australian mobile network operator has announced plans to deliver local access speeds in excess of 40 Mbit/s by 2009 using HSPA+ technology. Some expect that by 2012, this mobile network will be capable of theoretical speeds of 100 Mbit/s. Australian researchers are working on multi-Gigabit wireless data rates using millimetre wave spectrum. The deployment of such networks in Australia to complement other local area networks and for ad hoc communications may be possible within the next ten years.

Regulatory implications—broadband
Broadband access is of considerable interest to ACMA, which will report on availability and quality of service, allocate spectrum for broadband wireless and facilitate IP-based technologies.

2.2 DIGITAL BROADCASTING
TV and radio broadcasting are in transition to digitisation. Digital terrestrial broadcasting also competes with digital broadcasting via satellite and cable. In overseas markets where sufficient broadband bandwidth is being deployed (6 Mbits/s seems to be a benchmark), there is competitive internet delivery of broadcast-like services. In Australia, the market for IPTV services is at an early stage of development. In a globally interconnected market, local content will compete with directly delivered international digital content.

Mobile distribution of video content is developing as a complementary platform to viewing digital content on the television set and PC. Further developments in Australia are subject, in part, to the auction of Channel B. From an international perspective, development is dependent on the maturation of DVB-H standards.

Commercial digital radio is scheduled to roll-out in January 2009. Digital radio will be capable of providing text, multimedia and downloadable music.

Regulatory implications—digital broadcasting
ACMA is likely to have an ongoing role in allocation processes for the ‘digital dividend’—that is, allocating the spectrum that is likely to become available following the ultimate closure of analog transmission. Considerable preliminary work is required to understand the likely planning and allocation issues that will have a bearing on the realisable value of any such dividend.

Industry standardisation and bandwidth capacity issues from the deployment of high-definition (HD) services are relevant to ACMA now and in the near future. HD broadcasting will provide distribution of very high bandwidth traffic television to supplement broadband platform capacity. ACMA is currently researching IPTV developments in Australia as one element of change in the digital delivery of professional content.

2.3 SMART RADIO SYSTEMS—COGNITIVE AND SOFTWARE-DEFINED RADIO
While some smart radio capabilities are available now, a variety of new technologies are expected to evolve over the next decade. Cognitive radio (CR) and software-defined radio...
(SDR) technologies are frequency agile and share spectrum without interference. Ideally, CR can individually and dynamically adapt its spectrum usage, taking into account local RF conditions such as interference and demand (the number of users and the applications they are using).

SDR-operating parameters are defined by its software rather than its hardware, enabling it to tune into different frequencies and receive any modulation across a large frequency spectrum. By its design, the SDR can receive and transmit different forms of radio protocols simply by running different software. SDR enables fast upgrades and extremely flexible operation.

For example, a telecommunications company using a software-defined mobile phone base station may be able to use a software upgrade rather than an expensive hardware upgrade to implement significant changes to its network, subject to the limitations of radio-frequency input/output elements. A software-defined handset could then be upgraded ‘over-the-air’ to operate on the new network without the customer having to replace the handset. The many economic and technical advantages of SDR mean that its use will continue to grow.

CR is seen by many as a key enabling technology for making use of the so-called spectrum ‘white-space’—spectrum that is under-utilised by existing services. Of particular interest are the UHF television bands. A given channel in these bands may be unavailable for a high-power service due to the potential for interference to an adjacent area, but may support low-power services such as wireless local area networks. CR is likely to be attractive to licensees who currently manage self-coordination issues manually.

**Regulatory implications—cognitive and software-defined ratio**

The flexibility offered by SDR poses various regulatory challenges; in particular, facilitating the introduction of new services while managing the existing rights of incumbents. Widespread use of CR technologies may require changes to ACMA licensing arrangements. For example, the dynamic interference management capabilities of CRs may lend the technology to class licensing. ACMA could design a spectrum regulatory regime that takes full advantage of CR, which in turn would enable more efficient spectrum utilisation.

The timing for commercial cognitive radios is uncertain. However, it is worth noting that in the United States, initial prototypes appear to have failed Federal Communications Commission specifications for the protection of conventional devices from interference.

### 2.5 SENSOR NETWORKS

Sensor networks refer to embedded sensing and intelligence in materials and the environment. An early example of this is the development and deployment of passive Radio Frequency Identification (RFID) tags. Miniature wireless data chips are being embedded in objects, such as security passes or a medical patient’s wristband, that provide broad access to digital content in the physical world, ushering in new consumer and business applications.

Advances in nanotechnology and miniaturisation will mean that smaller objects will have the ability to interact and connect to networks more generally, such as local area networks in homes and offices. Elements within sensor networks can report on their location, identity, history, operational status and operational needs. With the deployment of sensor networks and ambient intelligence, networked and interconnected devices and the roll-out of IPv6, an ‘internet of things’ is expected to emerge over the next five to 10 years.
Ultra wideband (UWB) technology has also been used to create precision location RFID tags to allow the tracking of high-value items such as monitoring equipment, and doctors and patients in hospitals. (UWB can transmit data at very high speeds over a wide spectrum of frequency over relatively short distances.) Some of these devices use very low-cycle active devices rather than the more common RFID devices that only transmit when interrogated. This could potentially lead to issues with devices being active outside their normal operating confines.

Other examples of networked devices include domestic energy meter reading, smart measurement and control, status/fire/fault monitoring, smart fault rectification for electricity distribution and railway networks, and many more. Interconnection of these devices is by combinations of wireless networks and wired infrastructure.

**Regulatory implications—sensor networks**

The challenge for ACMA in managing the spectrum regulatory regime is to enable such applications to be deployed and, if necessary, to address any regulatory barriers to their mass deployment. Where these sensors are close to, or even inside the body, community concern over the public health and safety of the electromagnetic transmissions may become an issue for government and regulators.

RFID continues to cause privacy concerns on a national and international level. From a spectrum management perspective, the expectation is that spectrum will be available for the massive increase in communication traffic resulting from the commercial deployment of RFID technologies.

**2.6 MESH NETWORKS**

Mesh networking enables wireless network-enabled devices to establish low-cost, high-bandwidth, self-configuring and self-healing peer-to-peer networks over local geographic areas independently of managed access and control points.

Mesh networking has been used for border security and to provide communications links for large-scale public events. A group of individuals has formed SydneyFreeNet, using wireless mesh hardware and class-licensed WiFi for ‘free’ access to the internet.

**Regulatory implications—mesh networks**

Mesh networking is a new form of communication network. The application of existing telecommunications regulation may be tested where it is not clear who is providing the network (carrier) or service (carriage service provider), including whether there are multiple people providing multiple carriage services.

Associated responsibilities and obligations of ‘carriage’ and ‘carriage service’ may need further examination by ACMA where relationships between the parties are unclear. Defining where responsibility for access to restricted or illegal content shared over mesh networks might rest is likely to be contentious. Mesh networks have the potential to be used for localised voice connectivity. However, in a self-selecting community of mesh users, it may be difficult to distinguish between public and private communications over a mesh network. Individuals who set up and/or use mesh networks may not be fully aware of the consequences or risks associated with open access arrangements.
2.7 EFFICIENCY TECHNIQUES IN MULTIMEDIA TRANSMISSION

There are ongoing technological developments that increase the amount of data that can be transmitted over a given physical infrastructure. These developments occur in terms of:

- multiplexing—the number of channels that can be supported on the infrastructure, be it wireless, copper cable or fibre;
- encoding—the conversion of a signal from one format to another;
- compression—techniques used to reduce the actual amount of data carried while preserving as much of the original content as possible; and
- error-correcting—techniques used to detect, correct or reduce the impact of errors in digital transmission.

Relentless research and development in compression technologies is expected to better handle bandwidth demanded by HD video and multimedia services.

Research into FAST copper (Frequency Amplitude Space Time) proposes to leverage the installed copper plant, which is by far the most ubiquitous access network in Australia. The aim is to make 100 Mbit/s broadband access available over fibre-copper DSL architecture. The technique combines optimisation and signal-processing techniques with novel system architecture and protocols, as well as an integrated plane of real-time control, computation, data collection and auto-configuration.

The combination of advancements in encoding and compression techniques continues to deliver large increases in the effective capacity of existing infrastructure, and also contributes to new or innovative methods of communication. These developments have important economic implications for the carriage aspects of the industry and will make bandwidth-hungry services available sooner, hastening convergence.

Regulatory implications—efficiency techniques in multimedia transmission

Bandwidth-efficient techniques simultaneously increase the payload capacity of any infrastructure and reduce the spectrum bandwidth requirements of radiocommunications technologies. Offsetting this is potentially greater susceptibility to interference, which ACMA needs to consider in designing spectrum frameworks.

2.8 LOCATION-SENSING AND CONTEXT-AWARE TECHNOLOGIES

Wireless devices may know with increasing accuracy where a user is. Location-based services are expected to evolve through devices or objects with RFID and GPS connectivity. The Geographic Information System (GIS) is becoming more widely deployed for tasks such as requesting directions, locating services or directing emergency service response.

Examples of location services are mobile phones delivering location-based marketing and real-time traffic information, monitoring local, interstate and international delivery vehicles, monitoring limited-release prisoners, buddy finder services and directory-style information. They also encompass GPS functionality in mobile phones, digital cameras and real-time maps to hand-held devices and cars.

Content marked with location data has forged the development of what has become known as the Geospatial Web—the merging of geographical, location-based information with web-based information; for example, Google Earth. People-tracking and location awareness by machines (including position sensing & visual orientation) has emerged; however, an
understanding of how this might work is still developing, as is an appreciation of the regulatory issues.

**Regulatory implications—location-sensing**

Key issues for ACMA’s safeguarding role are privacy, security, location service accuracy and reliability for users generally. Some countries have mandated mobile location technology as another means to access emergency services.

### 2.9 INTELLIGENT TRANSPORT SYSTEMS TECHNOLOGIES

Intelligent Transportation Systems (ITS) use a broad range of wireless technologies that, when integrated into the transportation system infrastructure and vehicles themselves, help to monitor and manage traffic flow, relieve congestion, provide alternative routes to travellers, improve safety and save lives. The ITS technologies are enabled using Dedicated Short Range Communications (DSRC).

DSRC for ITS applications is the use of non-voice radio techniques to transfer data over short distances between in-vehicle mobile radio units and roadside units. They perform operations that improve traffic flow and safety, as well as other intelligent transport service applications in a variety of public and commercial environments.

**Regulatory implications—Intelligent Transport Systems**

Internationally, the US and Europe have allocated the 5.850–5.925 GHz frequency band for ITS. Mobile equipment is likely to be manufactured into vehicles imported to Australia from 2012 onwards. Currently, the Australian road transport industry through Austroads is preparing the way for the introduction of ITS by way of an extensive roadside radiocommunications infrastructure. ACMA has been liaising with the transport sector and actively planning for its introduction.

### 2.10 SATELLITE SERVICES

Satellites are an increasingly capable substitute for terrestrial access infrastructures. Far from being banished to niche markets covering remote and sparse populations over huge distances, they are a common access method for many mainstream services such as pay and free-to-air TV services. In telephony, remote area extensions to cellular services using satellite services are moving from niche to mainstream, while broadband services to aircraft can only be provided by satellite and are becoming a basic facility for commercial international travel.

Looking beyond communications, weather and other scientific disciplines will expand their use of sensing satellites, as public and commercial interests demand that weather forecasts, for example, be extended further into the future with a higher reliability. This will drive the need to gather more data more frequently and from more locations.

**Regulatory implications—satellite services**

ACMA is responsible for ensuring that satellites have access to appropriate spectrum that, given their nature, is likely to be harmonised internationally. Satellite services are particularly sensitive to interference and, even with developments in cognitive radio and other interference-management technologies, they will probably continue to require greater levels of interference protection than other services.
Australia will likely continue to use satellites domestically for some time, irrespective of the build-out of terrestrial infrastructure.

3. Distributed connectivity

Inclusive of computer networking and IP-multimedia services, this trend is perhaps most notable for the integration of information-processing beyond the desktop into everyday objects and activities, or what is sometimes described as ubiquitous computing.

3.1 COMPUTER NETWORKING TECHNOLOGIES

This section includes peer-to-peer networking, data processing, compression and storage, platform interface architecture and systems integration. The cost of storage is decreasing and demand is increasing. With solid state or flash memory (no moving parts as opposed to hard drivers) higher capacity storage can be incorporated into smaller form factors (eg. smaller sized iPods with multi-gigabyte storage capacity). Computers at the edge of the network, including PCs, game consoles and mobile devices, have ever-increasing processing and storage capacities. Increasing capacities and use of local storage and data re-use has possible implications for communications and media business models.

Peer networks enable new forms of voice connectivity, social interaction and file sharing independent of the carriage service provider. Control over application or service use is continuing to migrate from service providers to end-users (see Web Trends on page 14).

Regulatory implications—computing networking

Potential issues for ACMA include clarifying the balance between national and public interest responsibilities; for example, those in legal interception. Related issues are the deployment of home or personal-area networks and issues of network boundaries, interconnectivity and interoperability.

Shifts in control from service providers to end-users, more mobility and participation in communications and media raise important questions about the appropriate focus of regulation; that is, where responsibilities may rest, the need for digital literacy skills and the growing importance of consumer education and awareness.

3.2 IP-BASED SERVICES

The use of internet protocol (IP)-based transmission technologies is driving the design and use of telecommunications network and platform convergence. IP-based networks standardisation is an important international activity. Developed by the mobile communications industry, IP Multimedia Subsystem (IMS) is an open systems architecture that supports a wide range of IP-based multimedia services over packet and circuit-switched networks. IMS may form the basis of the convergence of fixed and mobile communications. Voice over IP (VoIP) and IPTV are examples of IP-based services and applications.

VoIP is one of the better-known manifestations of peer networking. ACMA’s research program includes examining the application of voice regulation to VoIP service providers. Some VoIP services allow calls to other VoIP services, some allow connectivity to traditional voice services, some allow only inbound calls to be made and some allow outbound calls. Skype offers a form of peer-to-peer voice connectivity over the internet. For each service type, differing regulatory obligations apply.
The evolution of multimedia telephony is likely to include value-added services that blend voice with other applications and Web 2.0 features—‘intelligent telephony’ would take context into account, such as defaulting to voicemail when the user is asleep.

An additional consequence may be that data carriage requirements will become more symmetrical. Currently upstream and downstream data requirements for residential internet access are generally asymmetrical, with the upstream path requiring much less data capacity than the downstream path. Increasingly, user interaction applications, such as Facebook, will require similar uplink and downlink capacities. This will impact on radiofrequency spectrum demand in wireless networks, as uplink and downlink RF bandwidths will need to be more balanced, and require a revision of xDSL deployment standards.

**Regulatory implications—IP-based services**

IP systems and IMS are of immediate interest to ACMA, which is currently considering how existing voice services regulation applies to a variety of VoIP services.

The regulatory framework was designed in a circuit-switched network environment and the transition to IP-based networks has forced ACMA to consider how existing regulations translate to an IP environment. Issues for industry and regulators include device interoperability, network interconnection, operational systems inter-working and access to IP-based networks.

A range of regulatory obligations that apply to the standard telephone service warrant further consideration for the provision of VoIP services. These will possibly include pre-selection, Customer Service Guarantee obligations, functional equivalence to voice services for the disabled, aspects of the numbering plan, application of the untimed local call, operator assistance, itemised billing and directory assistance requirements. ACMA is currently considering its approach to information, education and compliance for VoIP services.

**4. Emerging content and network management technologies**

Key issues in this theme are the increasing use of content monitoring technologies, and the need to improve e-security and identity management. More recently, there has been a growing awareness of the potential improvements to energy efficiency and use from distributed micro-generation in ‘smart-grids’. ACMA’s role covers aspects of all of these issues and public interest is expected to accelerate over the next 10 years.

**4.1 CONTENT MONITORING TECHNOLOGIES**

Content monitoring technologies include deep packet inspection (DPI) and content filtering software.

DPI examines the inside structure of data packets to determine their contents. If the technology was to be deployed in internet service providers’ (ISPs) networks it could potentially help them to know more about their users and traffic. ISPs would be able to block, shape, monitor and prioritise that traffic—in any direction. DPI is an enabler of traffic price discrimination.

DPI could be used by service providers to control or ‘shape’ traffic data flows to cope with heavy traffic threatening congestion. Likewise, it would help to prioritise differentiated traffic. It can be used to scrutinise content to decide whether to let it go through.
Content filtering software can be used to block access to specific content or categories of web-delivered content. The technology can be deployed by the end-user on home computers or on service providers’ networks (known as ISP filtering). When filters are deployed on ISP networks they can have a costly impact on network performance if they use a large index or undertake dynamic analysis of content.

**Regulatory implications—content monitoring technologies**

DPI has the potential to be significantly abused—service providers could discriminate between differentiated payloads, possibly for anti-competitive practices. Some regard DPI as a serious threat to the concept of internet neutrality.

Privacy may also be an issue through the secret monitoring of personal content without prior consent.

On the other hand, DPI is useful to law enforcement agencies in their interception and surveillance tasks. It could potentially be used in e-security operations—detecting viruses, spam, and violated rules and policies, and collecting use statistics.

Content filtering can be used to block access to restricted or illegal content. ACMA is interested in how end-users discover and effectively use content monitoring technologies.

**4.2 E-SECURITY**

As the internet and associated applications such as email and web browsers are used for an ever-increasing number of business and social transactions, organised crime is focusing increasingly on internet-related crime. One indicator of the growing economic importance of the internet is that the number of Australian internet banking users aged 16 years and older increased from 6.9 million in May 2006 to 8.2 million in May 2007.

Given the burgeoning online economy and increasingly sophisticated criminal incursions into this economy, particularly through the use of botnets, maintaining and enhancing the security of internet transactions and communications will become a growing priority. Anti-botnet measures will be increasingly important, given the role of botnets in stealing personal identity information, disseminating malware (malicious software) through spam and mounting attacks on internet websites through distributed denial of service attacks.

There will be a growing focus on website security to prevent legitimate websites from becoming unwitting hosts of malware. Social networking sites are likely to be prime targets of criminal attacks, as are other websites with significant potential for the harvesting of personal identity information, including government websites.

Improved authentication and validation systems for internet communication and transactions need to be developed, both for high-level transactions such as internet banking and for more routine communications such as email.

The international governance of the internet will be an expanding area of focus, particularly in areas such as domain management and assignment. Obtaining a balance between maintaining individual privacy and effective e-security arrangements will be a major challenge to these governance arrangements.

**Regulatory implications—e-security**

It is likely that coordinated government and industry action at the international level will be required to establish effective email authentication standards.
A multifaceted approach to e-security is necessary to maintain the integrity of internet transactions, and consumer and business confidence in undertaking these transactions. User education, effective legislation and enforcement, international cooperation, and the ongoing development and implementation of technical solutions and standards will be required to address e-security problems.

Strong cooperation between all levels of Australian government and with key stakeholders—particularly internet service providers—will be needed to ensure the success of these measures. ACMA has a significant role to play in all these activities.

4.3 IDENTITY MANAGEMENT

A digital identity is a set of attributes for an entity such as a person, service, device or an application. In order to assert a particular identity in each case, it is necessary to enable the mutual exchange of information that is relevant to the provision of a particular service or application, but which may also be personal or sensitive. The structure, security, storage, interoperability and availability of digital identities are requirements that form part of an Identity Management (IdM) framework. IdM has been developed by the International Telecommunications Union to progress standardisation processes for digital identity attributes.

Regulatory implications—identity management

Whatever form identity may take, there is a need to manage globally the parameters that together form the identity of users or objects. As IdM is likely to pervade all walks of life, and may manifest itself in a diverse range of technologies—including biochemical, biomedical, microelectronics, industrial control and physical resource management, as well as communications—the need for unified policies, legislation and codes is obvious.

The use of IdM in the delivery of communications and media services may be relevant to ACMA for standardisation of network and application layer addressing in Next Generation Networks. For example, the large addressing range available with IPv6 may enable these addresses to be used as unique identifiers for individual devices or objects connected to a network.

4.4 ACCESS AND MANAGEMENT OF DIGITAL CONTENT TECHNOLOGIES

Digital rights management (DRM) is the control and protection of intellectual property in content that is stored in digital form, including documents, images, video and audio. DRM attempts to limit what a user can do with that content even when in possession of it. The arrangements for managing digital rights might be a combination of encryption and validation processes, conditional access; for example, smart cards, or any other means used to secure and control access to digital content. These technologies may be contained within the operating system or program software, or be found in the actual hardware of a device.

In Australia and internationally, governments and holders of intellectual property are examining what action ISPs and end-users might take over illegal file-sharing. Some advocate legislative measures to force ISPs to take action. Others suggest self-regulatory measures. An example of responsibility being placed on the user, with increasing regulatory access channelled through the ISP, is to terminate the internet connections of those who are caught sharing pirated content.
Whatever controls are put in place, compliance is likely to be problematic. Various encryption techniques and proxy identities are also available to file-sharers to make monitoring such activity challenging. In an alternative approach advocated by the Swedish Performing Rights Society, file-sharing would be made legal by including the cost of music downloads in packages offered by ISPs.

**Regulatory implications—access and management of digital content**

ACMA does not have primary responsibility for protecting intellectual property but may have a role in promoting consumer awareness of rights and responsibilities. Other issues relevant to ACMA include industry standardisation for DRM, technology interoperability and access to information. As these technologies run in the background, there are potential implications for privacy and security—privacy may be an issue because access control is tied to individual user identities.

### 4.5 ENERGY EFFICIENCY APPLICATIONS

There is now a growing awareness of the effects of climate change and a focus on saving energy. The communications industry is a major user of energy by virtue of its facilities, installations, production activities, equipment and devices. As a consequence, the emerging reality is that industry has the responsibility to reduce energy consumption; for example, through policies, standards and codes governing devices and equipment. At the same time, its own technologies, innovations and developments have tremendous potential to assist other industries in their efforts to increase the efficiency of energy use. Important examples include digital IdM, web-based measurement, analysis and control systems heavily dependent on electronic acquisition, processing, transmission and the networking of energy-related information.

This is a fast-developing technology driven by the unprecedented business opportunities for the ‘greening of the bottom line’. Attention is being paid to techniques that measure energy usage parameters and allow energy data to be communicated and analysed. Video and web-conference tools now reduce the need to travel for work and allow more employees to work from home.

**Regulatory implications—energy efficiency**

ACMA potentially has an increasing role in promoting energy efficiency through industry co-regulation. This is driven in part by the government’s commitment to international agreements.

### 5. Web-based services and the emerging ‘social web’

Web-based technologies, falling under the umbrella term ‘Web 2.0’, have ushered in the era of user-generated content (UGC), and the continuous and seamless update of data and reusable services. For some years now, the web has enabled highly innovative developments at the edge. The web is now turning into both a platform and a database. Recent examples of this include the third-party development of applications programming interface (APIs), enabling interaction between programs on networked computers, mashups (content drawn from multiple websites) and widgets (portable code that any user can install and execute on their web pages).
5.1 SOCIAL NETWORKING SITES (SNS)
These sites enable individuals to ‘put their lives online’ by posting personal profiles and other information on dedicated. UGC, online media (music and video) and mashups, enabled by Web 2.0, are collectively known as the ‘participative web’. Social networking sites are examples of web-based innovation and demonstrate scale advantage (the ability to handle changes in use) and network effects (where the value of a network increases with the addition of a new user). SNS are used by journalists and others as a means of obtaining instant news or hook-ups with people on the ground at a particular event.

Traditional media are also attracted to the social networking market due to the growth in online advertising revenue. They are partnering with or acquiring social networking sites—perhaps the most well-known is News Corp’s purchase of MySpace. An Australian broadcaster has recently announced plans to build a community platform around its brands through online social networking.

SNS may evolve over the next five years to become integrated hubs for individuals, organisations and their extended networks to connect, communicate, access and share tailored news, information and entertainment. They are becoming social destinations in their own right, which can lead to a ‘blurring of the boundaries’ between online and offline worlds. Young people in particular have been quick to use SNS to share information about themselves, meet their need for self-expression, make new connections and organise social activities.

Some organisations see real-time collaboration through social networking as an effective way to manage large-scale and geographically dispersed teams, and for organisational communication.

5.2 MOBILE WEB
Although web access in most developed countries has largely been via a PC or games console, over the next five years this is likely to be augmented by web-enabled mobile devices. The mobile web is already well advanced in parts of Asia and Europe, and is beginning to emerge in other developed economies, including Australia and the US. Continued development of the mobile web is linked to location-aware services and mobile advertising.

5.3 INTERNET TV
Beginning with online video streaming and downloading through applications like YouTube, more advanced internet TV services such as Joost are now available. In about 10 years, internet TV may have high-quality pictures and streaming, along with established web features such as sharing and personalisation.

5.4 CLOUD COMPUTING
Also known as ‘computing on demand’ or ‘software as a service’, cloud computing is the shared use of distributed computing resources as an alternative to in-house IT applications and services using local servers or personal devices. Cloud computing offers scale flexibility and cost-efficiency, and has the potential to be highly disruptive to desktop computing technology within the next five years.
5.5 VIRTUAL IDENTITIES
While currently dominated by online games such as Second Life and virtual identities such as avatars on social networking sites or other online interactions, more forms of virtual world activity are anticipated. Developments may include enhanced reality (electrochemical stimulation of the brain), augmented reality (combination or blurring of real and digitally modified identities and physical environments) and telepresence (video conferencing with more sophisticated video capture through holographics). The blurring of the boundaries of real and virtual identities is currently being experienced most intensively by young people, but may become more widely experienced over the next 10 years.

5.6 SEMANTIC WEB
The semantic web involves using metadata to enable computers to process the meaning of data (intelligent agents). Although this has now been in ‘gestation’ for some time, an increasing number of companies are working to fully implement the semantic web. Over the longer term, the aim is to develop a common framework that allows data to be shared and reused across application, enterprise and community boundaries so that a machine can perform particular tasks to the extent that humans do now.

Regulatory implications—web-based services
Social networking is emerging as a platform where individuals and networks of people influence and shape behaviour, community views and corporate strategies. There are now issues of inconsistent regulation. The definition of ‘broadcasting’ under the Broadcasting Services Act 1992 specifically excludes streaming services, which are now covered by Schedule 7. However, Schedule 7 applies a much higher benchmark to permitted versus prohibited content.

The take-up and use of SNS is achieving broader recognition. Twitter is one of a number of such sites called to support the US InSTEDD project (Innovative Support to Emergencies, Diseases and Disaster), which aims to provide advice and warnings, and to coordinate aid in times of emergency. SNS services are seemingly well-placed to undertake this role because they transmit new developments instantly and can make connections with people on the ground. Should this initiative succeed, SNS might potentially complement traditional means of communication for emergency services.

ACMA’s role in providing consumer advice is extending to fostering digital literacy; that is, the ability to access, understand and create information in a convergent, digital world. Other relevant issues include consumers as producers, how social networks shape community values and expectations, user-led social action to prevent service providers from abusing private data and possible cybersafety risks to social networking services.

Future industry and regulatory issues include the development of open standards for identity and information security, platform interoperability and privacy issues. A current issue for users of SNS sites is ‘who owns the data’; that is, the rights of subscribers versus the rights of service providers for ‘ownership’ and control of personal information once it is placed online.

Emerging forms of virtual reality content may complicate the regulation of content depending on public attitudes to virtual activities and relationships.
Bandwidth-hungry content such as high-definition video and media-rich UGC, along with more distributed connectivity and increasing use of the internet, raise serious questions about web capacity and whether regulators may have a role in informing the public should users experience gridlock while online.

6. Continuing scientific and technological innovation

In combination, these innovations are driving advances in computing processing power, display technologies, artificial intelligence and nanotechnology.

6.1 COMPUTING PROCESSOR POWER

Moore’s Law is frequently quoted as the doubling of computer power every 18 months, a momentum which has held for the last three decades. Computing power is expected to continue to grow—consistent with Moore’s Law—over the next decade and beyond. The momentum around multi-core processors is building. IBM has recently announced a technological breakthrough whereby light is used instead of wires to connect hundreds of thousands of processing cores on a tiny chip. Expected benefits include reductions in cost and energy use, while increasing bandwidth.

Multiple cores on a chip potentially allow a processor to be dedicated to sub-tasks such as vision processing and speech processing. Indexing and searching image and video data is another emerging advance. These developments suggest further dramatic changes in the nature of ICT devices and services—which may create novel and unexpected challenges for ACMA.

Further in the future, and subject to considerable investment and research, is quantum computing.

Regulatory implications—computing processing power

Although they are unlikely to develop into standard consumer computer equipment, developments in this domain are of critical interest because of their particular application to breaking current factor-based encryption schemes. When and if quantum computing occurs, contemporary communications security will face a severe challenge.

6.2 DISPLAY TECHNOLOGIES

There are several emerging display technologies that, according to their respective backers, do a better job than either of the current large-screen contenders—LCD or plasma display. Canon has unveiled Surface-conduction Electron-emitter Display (SED) technology that is based on the same technology as traditional cathode ray tube (CRT) televisions, miniaturised and packed inside a flat-panel display. SED technology can create HDTV video quality with all the benefits of a CRT display without the CRT size. Sony and others have been working for several years on a technology called Field Emission Display, which has yet to reach commercial standards.

These are steps toward the goal of selling enormous, ultra-thin displays (or even wallpaper) televisions to all homes at affordable prices. Developments are also likely in the form of electronic newspapers, flexible screens, among others. Disposable screens on consumer products may also be feasible. There may evolve functional portable electronic-document readers with display that can unroll to a scale larger than the device itself.
These developments will lead to a much greater range of display surfaces, with electronic content consequently permeating virtually every corner of people’s lives.

**Regulatory implications—display technologies**

Content regulation issues may become more acute due to material being displayed or located in places that do not match community standards or that raise questions of what children should be exposed to.

Educating consumers about some of the complexities in the digital TV supply-chain may arise. For example, a consumer may have a HD-capable tuner but a screen that does not have the necessary resolution to show the program.

**6.3 ARTIFICIAL INTELLIGENCE**

Artificial Intelligence (AI) enables computers to recognise objects or patterns and perform tasks that usually require human intelligence. There is growing interest in consumer-oriented robots, such as robot dogs that are capable of understanding some human speech and intelligent humanoids that can walk down stairs, respond to verbal instructions and talk. Most useful robots are unlikely to be humanoid as such, but they are likely to be extensive users of spectrum in a variety of ways. Although many are sceptical, the promise of AI on the web continues to attract interest, and the possibility of breakthroughs in this area over the next 10 years cannot be dismissed.

**Regulatory implications—Artificial Intelligence**

Artificial Intelligence may need to be supported by rules governing decision-making and overall responsibility. Networked robots are likely to be another growth area in the use of radiofrequency spectrum.

**6.4 NANOTECHNOLOGY**

In broad terms, nanotechnology is the understanding and control of matter at the molecular and atomic level. A widespread transition to nanotechnology techniques could occur around 2015. The impacts of development activities are already being felt in the market, facilitating the emergence of communication devices like digital cameras, mobile phones and flat-panel televisions. Battery technology generally is improving at a slower rate than processing and chip technology, potentially limiting applications development. However, reducing conventional lithium ion batteries to nanoscale improves power density and recharge time dramatically. By developing computing in organic substrates rather than silicon, nanocomputing is likely to address the integration of information technology with biological systems.

As a pervasive and fundamental technological shift, it is hard to predict just what impacts nanotechnology might have on ICT, but they are important to monitor. The development and deployment of laser technology over the last four decades might provide an analogy. Further developments in nanotechnology might result in a large increase in sensor networks, including networks that reside either on or in the human body.

**Regulatory implications—nanotechnology**

Monitoring advances in nanotechnology will provide indicators of future demand for radiofrequency spectrum and ubiquitous computing.