NETWORK-ENABLED CONNECTIVITY – KEY TO FULL SPECTRUM RDT&E

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Abstract

The development of next-generation capabilities for both military and civil applications is becoming critically dependent on network-enabled Research, Development, Test and Evaluation [RDT&E] federates that have global interoperability and connectivity. In Defence application, Network Enabled Operations [NEO] promise 'the knowledge edge' and in civil application, NEO promise the 'economic edge'. Harmonisation of the international security interests with the international economic interests promises a 'win-win' situation that compels a shared vision of what the future must bring and a cooperative international plan to achieve it.

The paper examines recent efforts to enable range federates to 'plug'n'play' with constructive and virtual simulations in Defence application and places these efforts in context with the global space-port connectivity initiatives being taken in the civil space arena. To secure common objectives, the paper predicts that unprecedented international cooperation will be needed. The expected outcome of such cooperation is to yield a common investment strategy for next-generation range technology development – with a focus on improving safety, increasing flexibility, and lowering costs in support of all future capability development efforts.

In a world where the radio-frequency spectrum allocated for RDT&E (both military and civil) is being rapidly lost to other commercial purposes, the paper also argues that a coordinated international response will be needed to augment and secure globally recognized spectrum to support the whole future of capability development – from capability genesis to realization.

Overall, the paper promises to: predict the future of RDT&E for capability development in a network enabled environment, expose the threats to securing this future, explore the consequences of ignoring the threats – and provide up-to-date progress on the cooperative efforts being taken to counter those threats.

Introduction

Many of us will be familiar with the wealth of literature that now abounds on the topics of the Revolution of Military Affairs [RMA] and the Revolution of Business Affairs [RBA]. These topics are themselves a product of the rapid globalisation that is already well in evidence.

Even a cursory review of this literature places the future of air, land, sea and space capabilities at the forefront of national, regional and international attention. As well, the effects of RMA/RBA already bring testimony to the compelling need for convergence between the global security and economic interests.

As an example, we need only to consider the historical evolution of space and connect this with the likely outcomes of RMA/RBA.

The Evolution of Space

A few short years ago, space was seen to be the high frontier that would enable nations to have a situation awareness and response 'edge' over potential aggressors. The enabling technologies that supported these space endeavors were seen to be ground-breaking military technologies that were highly classified – where the Research and Development [R&D] of these technologies was directed, funded and controlled by Governments – and, for many years, their application was largely restricted to the Cold War Superpowers.

Today, the 'high frontier' has changed and the future enabling technologies and applications are increasingly being driven by commercial needs and the demands for global access to space services.

In essence, we are already seeing a paradigm shift in the evolution of future space and aerospace technologies – where the outcomes of both military and civil developments will carry the stamp of 'dual-use' technologies. There has never been a better time for a shared vision of the future to be agreed and international cooperation and commitment secured to fulfill that vision.

Economy as a future Driver

In global economic terms, the space community shares in initiatives that expect to achieve global spaceport connectivity in the near future along with the achievement of interoperability between families of satellites and their earth stations. These initiatives stand to serve a variety of different applications for the common good. Examples of such applications might include communications satellites, earth-observation satellites, satellites assisting with reconnaissance, surveillance and navigation, space-debris monitoring, space science and meteorological services, search and rescue, wildlife monitoring etc.

Security as a future Driver

In global security terms, the Cold War is over – and the coalition forces of this world have already been driven into the role of playing international policemen – where the future space and aerospace investments stand to better enable them to play a rapid response role in crisis mitigation and peace-keeping. In military circles, these space initiatives have had various labels over the years – beginning with the Global Range Capability Programme – as was described by Means [1991]. The current objectives were explored by Gehrig and Mabanta (2002) and now embrace the achievement of a global range capability where <u>all</u> military and civil platforms and capabilities can be tested anywhere in the world - by taking advantage of the uniqueness and variety of globally dispersed site capabilities and environmental conditions.

Global Connectivity – Economy and Security harmonisation

In the civil world – the future achievement of global spaceport connectivity is being deliberately planned - with expectation of its realization within the next thirty years. Interactions between live events, globally dispersed models and simulations and networked design tools are already happening – at the National Aeronautics and Space Administration [NASA] and at the European Space Agency [ESA].

These agencies have compelling reasons for doing this – to mitigate risk, to avoid the unnecessary replication of major and expensive facilities and to facilitate and expedite Research, Development, Test and Evaluation [RDT&E]. This has propelled the need for interoperability (between future Models, Hardware-in-The-Loop Simulations, Man-In-the-Loop Simulations, Test ranges, Launch and Recovery sites etc) into the forefront of scientific thinking.

The civil space world is not alone in recognizing the need for interoperability between the 'prediction tools' (models and simulations) and the 'observation tools' (ranges and facilities). The military space and aerospace developers also recognize the need. For example:

Peckham (1993) claimed: *'The approach to world problems is now multinational rather than unilateral, and for the foreseeable future, ad hoc coalition operations are to be the most likely engagement scenario for the use of military forces. .... In the past, multi-service interoperability has been difficult enough to achieve, and the added dimension of international coalition force operations makes the need for interoperability even more imperative'.*

Anticipating this, a concept was proposed even earlier by Smith (1990) to meet these demands: '*the creation of a large virtual-range environment whereby multiple, geographically dispersed test ranges may operate in concert'*.

This need was further expounded by Smith (1991) thus: *'... the challenge of 21st century testing will demand effective technology infusion into the test environments and an efficient networking of the family of laboratory and range assets. Reprogrammable architectures ... a satellite linked range community, and the ultimate marriage of our free-space and simulation test environments are key characteristics of tomorrow's world of test and evaluation. A world range concept offers a remedy for these problems.'*

The introduction of Network-Enabled Operations [NEO] into military thinking has also compelled a convergent approach to future RDT&E infrastructure investment - to enable connectivity between the networked ranges of the future [air, land, sea and space] and widely geographically dispersed models and simulations. As identified by the United States Congress Office of Technology Assessment (1994), this concept is not new to the military as the first application of distributed connectivity between live and simulated events occurred in 1953. What is new - is the shift in thinking from domestic applications to national and to international applications – and in a dual-use context.

In the United States, Bozack (1999) further explored this dual-use context - which built on the convergence of test and training requirements expressed by Walsh (1991) in the United States Joint Test and Training Range Roadmap. Crouch (2002) identified that an increasing emphasis on homeland security might well transform this 'Joint' roadmap into a 'National' roadmap.

Within this road-mapping initiative, the connectivity between multiple networked ranges with virtual and constructive simulations has already been exercised on a Joint Experiment known as Millennium Challenge – 02. Rumford (2002) suggested that this experiment bore testimony to the transformation of the RDT&E infrastructure in the United States to support the future assessment of all products, platforms and capabilities destined for future Network Enabled Operations.

It is also note-worthy that one of the prime movers in this effort was a programme titled Foundation Initiative FI-2010 – which, in the United States, builds on a High Level Architecture [HLA] nodal architecture titled TENA [Test and Training Enabling Architecture] that is laying the groundwork for integrated multi-range events. See Figure 1.

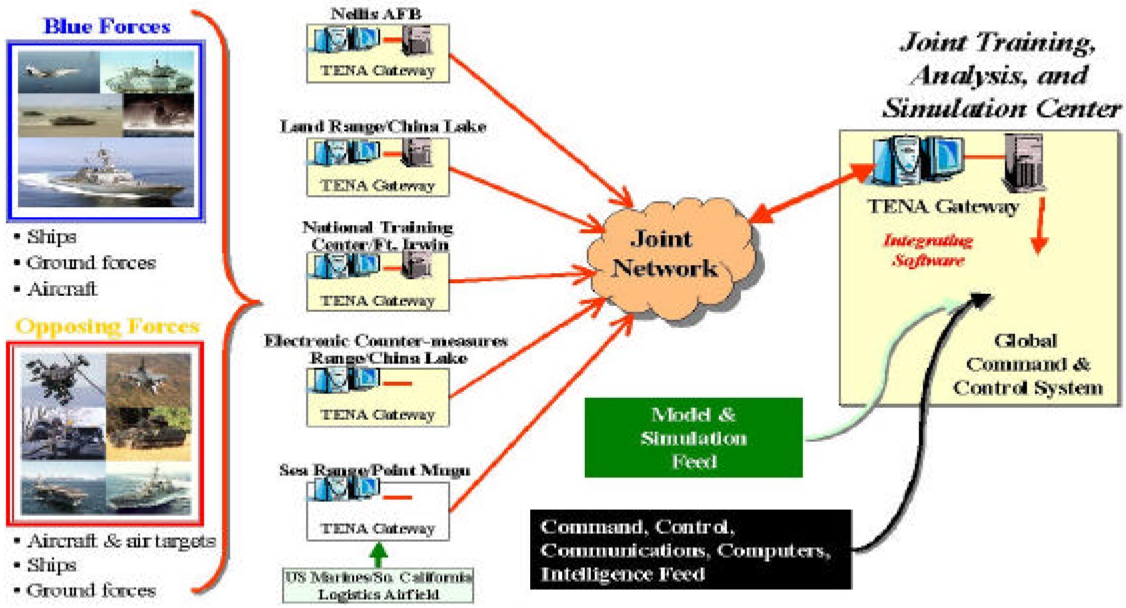

Figure 1 Range Networking – MC-02

Future Shared Vision – The Need

In parallel with these initiatives, the United States White House Office of Science and Technology (2000) directed the development of a shared vision of the future among all the civil and military stakeholders. This directive included *"sensor and C2 capabilities necessary to safely conduct national security, civil, and commercial space launch operations, as well as test and evaluation of land and sea-based ballistic missiles and other systems."*

This directive established an Advanced Range Technology Working Group [ARTWG] and an Advanced Space Technology Working Group [ASTWG]. These two working groups have subsequently held three annual conferences to facilitate a shared vision and to agree on a roadmap to the future - in 2002, 2003 and 2004. As an outcome of these efforts, the working groups have already agreed what the challenge for the future is – and where the major areas of emphasis for future scientific inquiry and strategic planning lie. Booz et al (2004) published these findings as a future concept of operations for space launch and test ranges which consolidated all stakeholder views as a whole-of-nation effort.

Notably, this activity incorporated the like-minded efforts that were already underway within the US DoD and within NASA. One example of this is NASA's Space-based Telemetry and Range Safety Study (STARS) which, as explained by Valencia (2004) aims to determine and demonstrate the feasibility of utilizing the existing space network to provide communication paths between research aircraft, launch vehicles and mission / launch control centers.

The challenge however, as expressed by these two Working Groups is not unique to the United States - it is global! A cooperative vision is therefore needed – to cover both military and civil use of space and aerospace applications. In fulfilling this vision, it also needs to be recognized that no one country in the world can any longer afford to own all the unique features and capabilities it needs – inclusive of the observation tool investments (networked launch sites, tracking and test ranges and facilities) and the connectivity of these with the growing number of Modeling, Simulation and Experimentation federates.

Making the point that the achievement of this connectivity is now an international imperative, Crouch [2004] also identified that the achievement of this future capability closes off the scientific method of *'prediction, observation, comparison and refinement'.*

With respect to the observation tools – this method of closure on the scientific method recognises the availability of unique conditions that are enjoyed by specific ranges, facilities and launch/recovery sites. Such conditions can include weather, a suitable electromagnetic environment, specific topography, political stability, orbital optimization, ease of maintaining security, safety, and ease of achieving connectivity, compatibility and interoperability with others etc etc.

Smith (1991) referred to this as the: "*The hooking things together problem - as this is not just a Defence problem. The private sector is facing the same dilemma, but without the DoD's advantage (or some would say the disadvantage) of central management."*

The connectivity stakes are therefore high – so it is valuable to focus on this issue. With respect to future connectivity – there are already a number of dual-use initiatives under way to cover the architecture and information exchanges between the various prediction and observation sites.

As explained by Morse [undated] this initiative includes those taken by the Simulation Standards Interoperability Organisation [SISO] in the United States to develop an IEEE standard – as well as the effort being made by the National Institute for Standards and Technology [undated] to facilitate virtual design efforts among geographically dispersed agents.

RF Spectrum – A Critical Issue

The aspect of future connectivity that is not receiving deserved attention however - is where the achievement of future connectivity requires the use of radio-frequency spectrum – for no spectrum is currently globally identified as being set aside for that purpose. It is also especially important to recognize that RDT&E for next generation systems needs RF Spectrum that is <u>additional</u> to that used to support operational platforms and this additional spectrum must be <u>non-intrusive</u> to operations – otherwise the achievement of operational realism during tests or experiments is compromised.

According to Crouch (Jan, 1997) this 'non-intrusive' spectrum used to be readily available at the ranges and launch sites around the world and was being self-regulated to comply with the recommendations of the Inter-Range Instrumentation Group [IRIG] standards that are promulgated by the United States Range Commanders Council [RCC]. Nine years earlier, Spotts (1988), expressed similar sentiments thus:
"The RCC Telemetry Standard (IRIG-106-86) has become the authority for developing and using telemetry systems not only range-wide but worldwide. The timing standard (RCC-Document 200-70) is also recognized worldwide as the principal source document for establishing and maintaining accurate timing systems."

In the face of spectrum deregulation however, the ranges and launch sites have found themselves with no globally coordinating representation on spectrum matters. Notably also, this lack of representation comes at a time when the national regulatory bodies for spectrum management are themselves under siege – as was highlighted by Sinder [2004].

Figure 3 is an indicator to some of the current telemetry spectrum congestion. The figure should be interpreted as a broad indicator. Although inaccurate in detail, it does illustrate that the spectrum currently used for air, land, sea and space telemetry applications:

- is becoming more and more congested;
- that spectrum losses to other uses are already happening and others are forecast;
- that there is a lack of global harmonization;
- the further erosion of capability is imminent in the absence of global representation.

With respect to addressing this spectrum coordination issue, it is important to understand that the Consultative Committee for Space Data Systems [2004] operates under a charter that is exclusive to *'peaceful purposes'*.

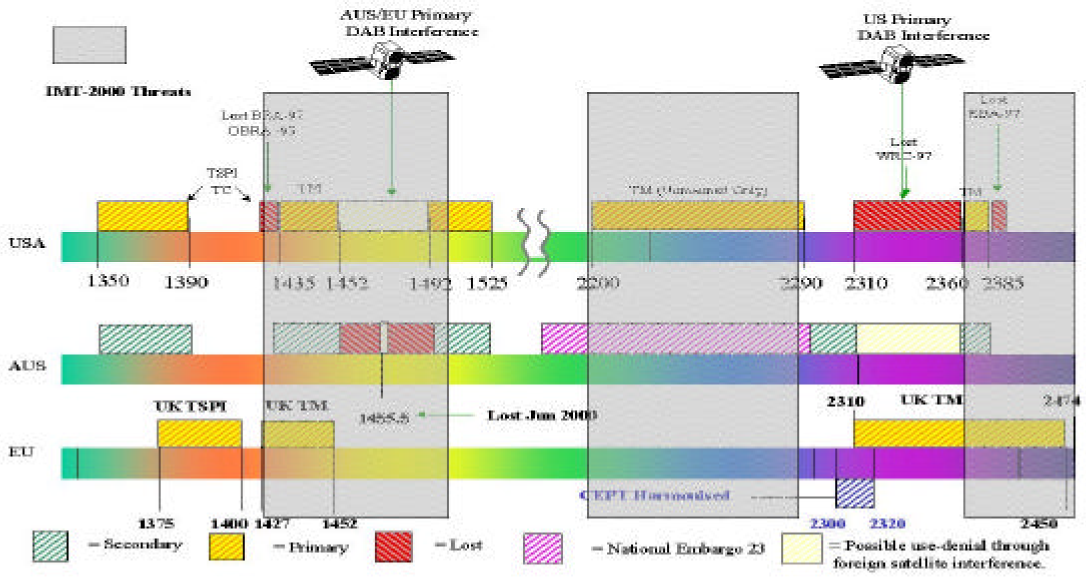

Figure 3. Telemetry Band Congestion

Within that confine the CCSDS sponsors the Space Frequency Coordinating Group [SFCG] – which represents the needs of the CCSDS member nations among the relevant Working Groups of the International Telecommunications Union [ITU].

A limitation of this approach – even for peaceful purposes - is that the SFCG charter does not include the RF spectrum needs associated with the RDT&E of sub-orbital vehicles. This places the satellite and ground based range facilities that are needed to support next generation launch platform and space technologies development at risk. Also at risk is the spectrum support needed to meet the operational needs of 'orbital insertion, orbital extraction and/or payload recovery'.

This poses a dilemma - where the future aspirations of the CCSDS member nations can be compromised by global inattention to the RF spectrum issues associated with getting their experiments into space via sounding rockets, developing next generation launch vehicles and recovery capabilities - as well as getting their operational platforms into actual use. In particular this includes the spectrum support for command/destruct and its application to orbital insertion and/or recovery.

In essence, the spectrum used at the civil launch and recovery sites is the same spectrum that is used for all military and civil air, land, sea and space developments. Crouch (1994) asserted that this is true all around the world thus: *"Based on the background research that was conducted there is little doubt that increasing levels of international cooperation will become more important in the future - to reduce costs through resource sharing. The telemetry standards inclusive of the recommended frequency assignments thereby form the baseline upon which this future will be built."*

Apart from the space community, the lack of representation on this spectrum also places the future of both military and civil aerospace development at risk – with direct effect on the test and evaluation of all next generation sub-orbital platforms – inclusive of aircraft, UAVs, RPVs, ionosondes, target drones, sounding rockets, missiles, re-usable launch vehicles etc.

As well, the bandwidth demands for supporting the RDT&E of such platforms is becoming exponential – at the same time that the spectrum availability for these purposes is both decreasing and becoming increasingly at risk. See Figure 3.

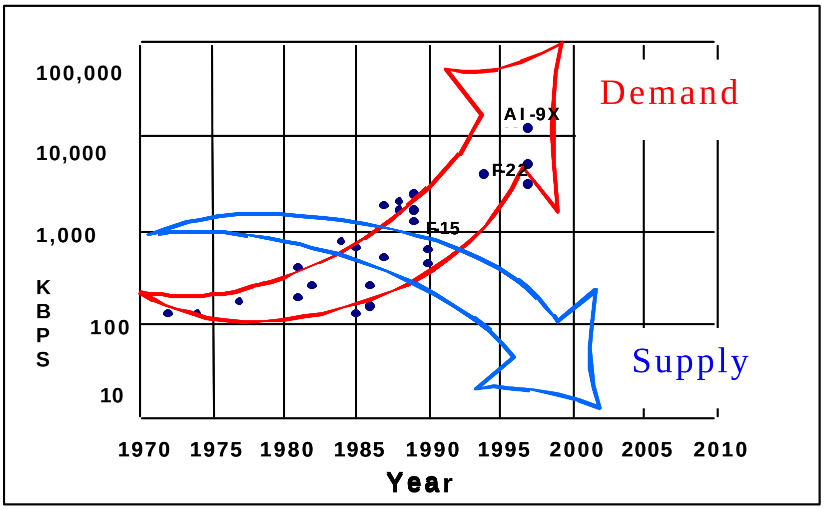

Figure 3 Telemetry Spectrum – Demand and Supply

Given these bandwidth trends, Hinton [2003] has already predicted that up to 203MHz of contiguous telemetry spectrum will be needed to accommodate the future testing of new platforms – such as the Joint Strike Fighter and next generation UAVs – where the *"best solution is to recognize current and future trends and to initiate a focused research and development programme."*

As identified by Crouch (1994), Australia independently anticipated these bandwidth trends ten years earlier and instantiated a research programme to help mitigate risk. This programme was fuelled by collaborative research grants from the Australian Research Council, the Department of Education and Training, the Air Standardisation Coordinating Committee and the United States Air Force Asian Office of Research and Development. Progress was reported by Sydenham (1994) and Samaan (1995) , extended to a global research issue by Crouch (1997) and with further research findings reported by Panton and Cook [2000].

Current Initiatives

Despite the critical dependency between both military and civil telemetry spectrum users – no one agency has been providing global representation on this issue or providing consolidated input to the ITU Working Groups on this topic – until very recently.

Recent initiatives include the formation of the International Consortium for Telemetry Spectrum (2004), which operates under the sponsorship of the International Foundation for Telemetering [IFT].

The ICTS recognizes: the potential impact of spectrum loss on critical infrastructure (in the order of billions of dollars). It also recognises that further spectrum erosion could isolate each range and launch site on planet Earth – where each will be left with unique electromagnetic compatibility and frequency allocation problems that are expensive to fix.

The ICTS is also assembling an understanding of the specific science and technology initiatives that are being undertaken around the world to help mitigate risk. As was explained by Tedeschi (2003), these programmes include those being undertaken in the United States via the Test and Evaluation Science and Technology Programme [TEST] and the Central Test and Evaluation Investment Programme [CTEIP] – where next-generation spectrum-efficient technologies are being researched and incorporated into the Advanced Range Telemetry Modernisation Programme [ARTM] and the Third-Generation Range Space Wireless Networks [3GRSWN] of the future.

As well, the ICTS is attempting to paint pictures of the economic impact. For example, in Australia alone, various figures have been produced to quantify annual Defence expenditure on T&E – which is a primary telemetry user – both domestically and internationally.

These figures range from that made by the Australian National Audit Office (2002) – which estimated an average expenditure of $270 million dollars per annum - to a specific instance reported by Bishop (1996) – where Defence spent $1.5 billion dollars on aviation T&E alone. Notably, these figures are for Defence only - and do not even attempt to establish the annual 'national' expenditure – let alone enable aggregation to help build a global picture of the economic risk.

Also not examined is the cost and schedule risks associated with every programme that is either under way or being planned – regardless of whether the programme involves testing concept demonstrators or testing products that are nominated in the plethora of predicted or approved acquisition programmes.

This makes little sense - given that booking a test range can cost in excess of one million dollars per day. As an outcome of this inattention, a whole variety of different programmes are now at extreme risk – but the potential costs – across the board - have yet to be requested, assimilated or reported as an aggregate. It is feared that Australia is not alone in recognizing the lack of attention to spectrum impacts and risks. For example, as was reported in the United States by Rumsfeld (2001); *"we are on notice but have not noticed"*.

All of these efforts by the ICTS, whether scientific, economic or cultural, therefore form crucial components of risk mitigation – but they do not, in themselves, propose or agree a future shared vision. A brief summary of the ICTS initiatives to remedy this now follows.

7. ICTS

The agreement to form the ICTS was made in 1999 at the European Test and Telemetry Conference that was held in Paris. Crouch (1999), the provisional chair of the ICTS, subsequently set the scene via an investiture statement that was made to all the conference delegates: as follows -*"In her key-note address, Dr Patricia Sanders mentioned how the future seems to be arriving faster and faster - that this was compelled by rapid world economic changes and security threats and matched by an accelerating rate of change of technology. In his trilogy on the Hitchhiker's Guide to the Galaxy, the author, Douglas Adams, wrote also about how fast things can happen. He concluded that the only thing in the Universe that traveled faster than the speed of light was bad news!! Ladies and Gentlemen, as the provisional Chairman of the ICTS, I want us all to bring the world 'good news'. If Douglas Adams is right, 'good news' travels slower than the speed of light - but the timeliness of your contributions will be key to how fast this can happen at all. The provisional ICTS executive does have your interests at heart and I therefore encourage you all to join with us in this timely initiative."*

In its evolution since 1999, the ICTS now recognizes that:

- spectrum utilization is increasing rapidly and this trend is expected to continue,
- telemetry is critical to the economic and security goals of many nations,
- frequency bands used for telemetry have been reallocated for other use and continue to be at risk of reallocation,
- increased demand for telemetry spectrum parallels the demand in the general telecommunications industry,
- telemetry data rates are increasing, thereby increasing the RF bandwidth needed for each mission, and
- additional frequency band allocations for telemetry may be unavailable or cost prohibitive.

The inaugural report of the ICTS, which summarised the actions being taken around the world on these topics, was published in the International Telemetering Conference ITC-2002 proceedings – and it has been updated annually since that time – as a service to all.

As illustrated at figure 3, the ICTS agreed a three-pronged plan to: defend what we have, develop technologies for near-term growth, and research ways to meet far term growth. These efforts were summarized by the International Foundation for Telemetering (2002) via publication of an annual report.

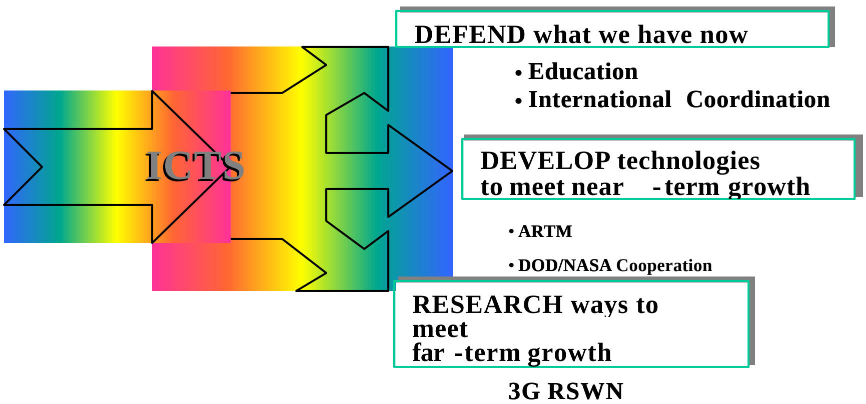

Figure 3 ICTS Major Thrusts

As explained by Chalfant (2002) the most urgent action forecast for the ICTS was to prepare for an agenda item proposed for the 2007 World Radio Council *… to consider spectrum requirements for wideband aeronautical telemetry in the band between 3 GHz and 30 GHz*. This agenda item was voted on in June 2003 at WRC-03 – at which the International Telecommunications Union (2003) agreed: *"to conduct, as a matter of urgency, studies to facilitate sharing between aeronautical mobile telemetry and associated telecommand …"*

We cannot therefore afford for our preparations to be too little and too late, a risk that was recognised by United States Department of Transportation testimony before Congress – where Shane (2003) expressed his concerns that the: *"2007 Conference will … consider the need for increased radio spectrum to support aeronautical telemetry. This is especially important to our aircraft manufacturers and the military, so that they can safely and efficiently test new aircraft. It is also becoming important to the safety of the Nation's airspace, as this telemetry is largely used to control unmanned aerial vehicles (UAVs) that will increasingly fly in the airspace used primarily by commercial aircraft today."*

Within Australia, as one example of recent attention, the national security implications of the RF spectrum have been recognised – via a proposed amendment to the National Telecommunications Act (2003) to: *"ensure that national security and law enforcement interests are considered before telecommunications carriers are granted an operating licence."*

As well, a concise version of the Australian Department of Defence Spectrum Strategic Plan (2004) has been publicly released where cognition has given to the fact that: *"lack of international harmony in telemetry frequencies and the absence of national allocations specific to aeronautical telemetry, is a risk area of some magnitude."*

As revealed by the Australian Academy of Science (2003) this risk area also needs to be communicated and considered during the preparation of complementary strategic plans that are reliant on the future of telemetry and telecommand capabilities – such as the development of Australia's Strategic Space Weather Plan.

In addition to these examples, cognition has also been given by Crouch (Oct, 2002) to the hostile environments in which future military telemetry applications must be sustained – hence helping to identify that future telemetry spectrum cannot be arbitrarily allocated. These considerations were identified thus:

"Compared with civil application, Defence test, training, experimentation & exercises have both common and unique telemetry data link vulnerability problems where the solutions are specific to the spectral occupancy of the telemetry channel(s).

- *Battlefield obscuration by-product effects.*
- *Clutter – specular ghosting – littoral environments*
- *Atmospheric – attenuation*
- *Space Weather - fading*
- *Countermeasures – anti-spoofing*
- *Safety – link reliability – high dynamics – plume attenuation.*

In addressing some of these vulnerabilities however, examples exist of national security concerns that prevent the public release of information, which would assist WRC-07.

One example of this security-sensitivity is global understanding of the effect of missile plumes on telemetry propagation – a problem where modeling such effects has proven to be intractable by Bagh Dady (1965, 1966) and only estimable via observation as revealed by Giddens (1968) and Gubbay (1974). Yet – this is a topic that needs to be covered comprehensively in order to prepare for WRC-07 in an informed way.

In the face of the need to understand the current politics, the national cultures, the changing regulatory environment, the legacy of secrecy, the physics and the future need, the major objectives of the ICTS were therefore agreed to be:

- To help defend the existing spectrum by populating a global use matrix.

- To help us to better use the spectrum we already have by understanding what research is being performed to realise spectral efficiency improvements and to strive for scalability to higher information rates - should additional spectrum become available.

- To help bring the far-term into focus by identifying new research initiatives and to give opportunity for future cooperation and collaboration.

In addition to the above initiatives, the ICTS meets regularly at the annual International Telemetering Conference in the United States and at the annual European Test and Telemetry Conferences – which are hosted by France and Germany in alternate years.

In 2004, it was agreed that an ICTS plenary session would be held, for the first time, in the Asia/Pacific region – at the annual Systems Engineering and Test and Evaluation Conference – or SETE-2004. This will offer a first step towards annually drawing the community of telemetry researchers and users within the Asia/Pacific together – in order to better identify regional vulnerabilities and to contribute regional views towards a globally consolidated view.

Noteworthy is that the investment in telemetry research by some regional countries has been considerable. For example the Beijing Institute for Telemetering (2002) is staffed by 1600 employees and is fully engaged in delivering post-graduate qualifications in instrumentation, telemetry and tele-command.

As an assistance to telemetry researchers and users within the Asia/Pacific region, all ICTS news of interest is therefore being disseminated via ITEA Southern Cross Chapter T&E Newsletters which are web-published at: http://www.unisa.edu.au/seec/news/newsletters.asp

Future Vision – Proposing it and Agreeing it.

The ICTS view is that the existing three-pronged initiatives are critical – but what these efforts fail to do is to actually propose and agree what the shared future vision actually is – so that all these efforts can be harmonized, prioritized and the needed level of mutual cooperation and collaboration actually secured.

The global maps being produced by the ICTS might therefore be useful for focusing our thoughts but, as expressed by the United States Department of Defense and Accounting Services (2001) : *"If you don't know where you are going – a map won't help."*

The ICTS is currently aware of only one published roadmap to the future that attempts to accommodate the needs of the space and aerospace stakeholders (both military and civil). It was produced by the Advanced Range Technology Working Group (2004) and its recommendations were as follows:

- *Near-term (FY 2004-2009)*
  - *Baseline=current ranges plus planned modernization including GPS metric tracking*
  - *Pursue technology development*
  - *Demonstrate utility of space-based and mobile systems for telemetry and commanding*
  - *Use space-based and mobile assets to supplement capacity and geographic coverage*
  - *Mid-term (FY 2010-2015)*
  - *Use space-based and mobile assets to supplement capacity and geographic coverage*
  - *Support flight test scenarios and operations involving multiple ranges, new areas*
- *Far-term (FY 2016-2028)*
  - *Transition to primarily space-centric range concept for regular operations*
  - *Deploy and make regular use of mobile range assets when and where needed*

Summary and Recommendations

I trust that it has been made clear that sub-orbital platforms are of interest to the space community as well as the aerospace community – and that both need the same spectrum support at the launch sites and test ranges around the world - to support the future international economy and security.

A clear vision of the future is therefore needed that consolidates both the international security and economic interests. This consolidation is not being facilitated by either the CCSDS or its companion military space or aerospace committees because of real or perceived limitations in the charters of each of these committees.

The ICTS, under the sponsorship of the International Foundation for Telemetering is now attempting to bring all the stakeholders together – to break the current 'paralysis paradigm' – so that a shared future vision can be proposed and agreed.

In essence, regardless of whether you are a civil user or a military user – space or aerospace – we need to hang together on this or we will surely hang separately.

The following course of action is recommended and strongly urged.

- Access and read the ICTS Annual Reports
- Register your interest with the ICTS and get to know your regional coordinator
- Assist the ICTS to populate the global use matrix so we all know where we stand
- Understand how spectrum issues impact on your organization's aspirations
- Know who your national spectrum representative is and how to access them
- Appreciate who is working on the next-generation technologies and who you should be working with – to solve mutual problems
- Plan to participate in the ICTS meetings – to table your problems, concerns and views

There has never been a better time for a shared vision of the future to be agreed - and for the needed degree of international cooperation and commitment to be secured to fulfill that vision. Not all nations might be participating in future space and aerospace development initiatives – but their risk-free dependencies on the success of these initiatives are under critical threat as well.

We therefore need to think globally – rather than domestically – which is a shift in thinking that was well forecast by the Australian Government Department of Foreign Affairs and Trade (1997) and expressed as follows: "*Over the next fifteen years, globalisation will reinforce the need for policy makers at all levels of government, no less than business people, to think in an international context*".

This international context is also of growing importance to Australia, given:

- The recent news release by the Simulation Industry Association of Australia (2004) on the Australia-US Joint Combined Training Centre [CJTC], which aims to network across a variety of the Australian air, land and sea, ranges and bring connectivity with virtual and constructive simulations.
- South Australian Government news (2004) covering international space, aerospace and other programmes being targeted for application at the Woomera range in South Australia.

The World Radio Conference in 2007 will be the <u>defining moment</u> for this issue however. We must therefore treat this issue as one that demands urgent global attention – and one that in hindsight, we are never compelled to explain to future generations that our efforts were too little and too late.

Let us therefore join hands – so that the future offers the best quality and security of life to our citizens that we can afford. After all, the future is not something we hand down to our children as a legacy of either our activities or inactivities – the future is something we borrow <u>from</u> our children. Let us therefore borrow wisely.

<u>Author Statement</u>

The views expressed in this paper are those of the author and do not reflect the official policy or position of the Australian Defence Science and Technology Organisation, the Department of Defence or the Australian Government.

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