From:	no-reply@mbie.govt.nz
To:	Research, Science and Innovation Strategy Secretariat
Subject:	Draft Research, Science and Innovation Strategy submission
Date:	Sunday, 10 November 2019 2:28:26 p.m.

Submission on Draft Research, Science and Innovation Strategy recevied:

Are you making your submission as an individual, or on behalf of an organisation?
Individual

Name
Richard Gordon Simpson

Name of organisation or institutional affiliation
Meta Moto

Role within organisation
DIrector

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Which of the below areas do you feel represents your perspective as a submitter? (Please select all that apply)
Researcher, Commercial user of research, Non-commercial user of research, Entrepreneur, Provide services to researchers, Provide services to users of research

If you selected other, please specify here:

Gender

Ethnicity

Name of organisation on whose behalf you are submitting, if different to the organisation named above

In which sector does your organisation operate: (Please select all that apply)

If you selected other, please specify here:

How large is your organisation (in number of full-time-equivalent employees)?

Please indicate if you would like some or all of the information you provide in your submission kept in confidence, and if so which information.

Please upload your submission document here
191110-Submission-to-NZ-RSI-strategy-by-Richard-Simpson.docx - Download File

MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

Research, Science and Innovation Strategy

Submission form

The Government is developing a Research, Science and Innovation (RSI) Strategy to set out our vision for RSI in New Zealand and its role in delivering a productive, sustainable, and inclusive future.

We are keen to hear the views of New Zealanders on the draft Strategy so that we can get a better understanding of what our country needs from RSI. We also are looking for feedback on how we can take action to ensure New Zealand's RSI system is optimised for success. These views will inform the direction of Government investment in RSI and the research and innovation areas for us to focus on as a country, as well as help us understand the challenges we need to overcome.

We encourage anyone with an interest to make a written submission.

How to have a say

We have included a number of questions in the draft RSI Strategy document to highlight issues on which we would like further input. We encourage you to use these questions as a guide when submitting your feedback.

This document provides a template for you to provide your answers. Please upload the completed document using our online submission page.

You do not have to fill out every section – we welcome submissions on some or all of the questions.

The closing date for submissions is 10 November 2019.

After the consultation period finishes, we will analyse the submissions received and incorporate the feedback in the final version of the strategy.

Confidentiality

Please note: All information you provide to MBIE in your submission could be subject to release under the Official Information Act. This includes personal details such as your name or email address, as well as your responses to the questions. MBIE generally releases the information it holds from consultation when requested, and will sometimes publish it by making it available on the MBIE website.
If you do not want some or all the information you provide as part of this consultation to be made public, please let us know when you upload your submission. This does not guarantee that we will not release this information as we may be required to by law. It does mean that we will contact you if we are considering releasing information that you have asked that we keep in confidence, and we will take your reasons for seeking confidentiality into account when making a decision on whether to release it.
If you do not specify that you would prefer that information you provide is kept in confidence, your submission will be made public. While we will do our best to let you know that we plan to publish your submission before we do so, we cannot guarantee that we will be able to do this.

Contribution of Research, Science and Innovation

This strategy is about New Zealand's Research, Science and Innovation (RSI) at a high-level. Its aim is to identify challenges and opportunities that will have the broadest impact on our research and innovation activities. For this reason, it mentions few specific areas or sectors of research and innovation. For this draft version of the Strategy, we are keen to hear from researchers, innovators, businesses, and providers of public services on what the RSI system could be doing to accelerate progress on Government's priorities.

Question 1: Where can the RSI system make the greatest contribution towards the transition to a clean, green, carbon-neutral New Zealand?

Question 2: Where else do you see it making a major contribution?

Question 3: What else could else the RSI system be doing to accelerate the progress towards the Government's priorities*?

Please type your submission below. If applicable, please indicate the question(s) to which you are responding.

Question 1:

Focus of RSI should be directed towards Digital Earth as an overarching strategy and framework. Digital Earth is a global initiative and more proactive structured contribution by New Zealand would both build a next-Knowledge economy and through innovation and international collaboration help ensure transition to a clean, green, carbon-neutral New Zealand.

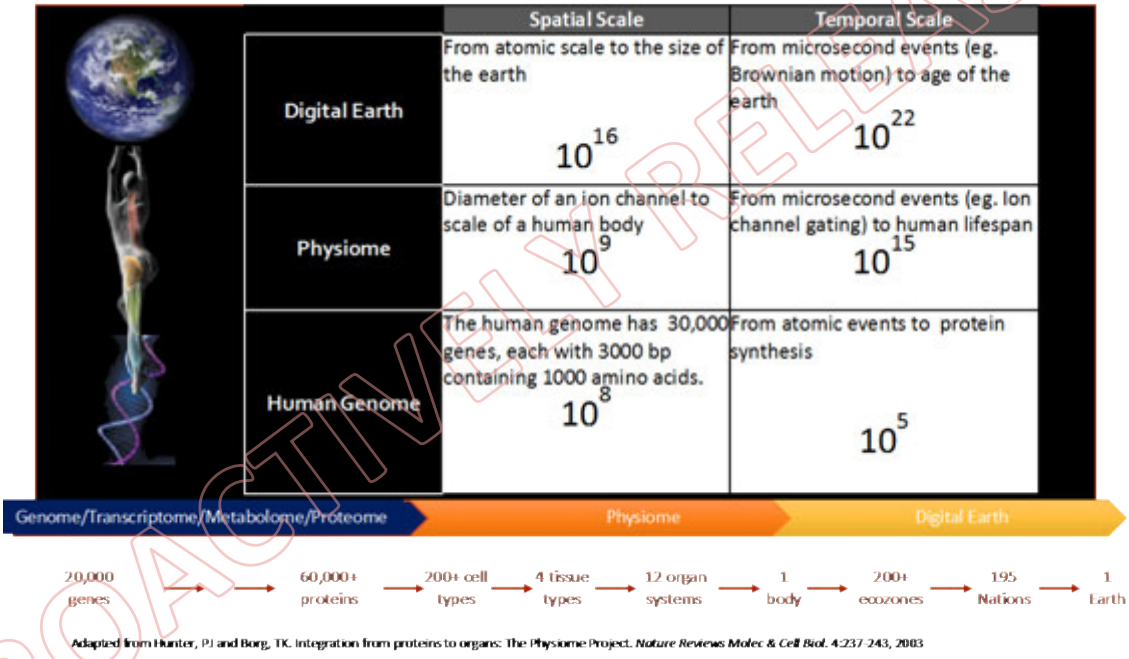
Question 2:

Digital Earth is a grand big-science initiative. It is global 'collaboratory' project akin to the pursuit of the Human Genome and Physiome. Digital Earth emerges as a commons for describing the digital built, natural and social environments. Every 10 years the International Society of Digital Earth (ISDE) brings together leading scientists, technologists and thinkers and issues a revised vision informed by advances in sciences and technologies. Digital Earth is framed as an emergent digital twin of the complex adaptive systems within the world we live.

This recent NZ Government report on air data serves as an illustration of how these three examples of Big-Science initiatives could be purposely coupled and offer a new paradigm for knowledge acceleration and deepening scientific insight into how the world we live in functions and exposes us to risks. As a relatively simple example of an interplay - Digital Earth may be applied to describe a comprehensive simulation of virtual pollution field – for example the spread of fine particle emissions from traffic, risks of asbestosis from structures, or carcinogenic chemistry taking place in sheltered park areas with oxides of nitrogen with factors such as high UV and salt air. The Physiome can describe an individual's (or populations') virtual lung operating in this virtual pollution field. The Physiome models are typically applied to drug discovery

and testing and simulate across scales from the subcellar biochemistry, the physiology, and bio-mechanical functions of the organ). The Human Genome outcomes serve to determine the genetic predisposition and inheritance and functional influences of the lung.

Through being able to work across the spatio-temporal scales of these three big-science initiatives we will be better positioned to gain an acute understanding of risks to individuals and population of a situation, inform better planning and decision making for our cities, and to advance more collaborative research to build our understandings. Please note this example is relatively simplistic as there are other global scientific projects who would converge into this 'solution space' such as the Metabolome, Transcriptome etc.



Adapted from Hunter, PJ and Borg, TK. Integration from proteins to organs: The Physiome Project. *Nature Reviews Molec & Cell Biol.* 4:237-243, 2003

Questions 3:

A Strategic Unit for Digital Earth should be established in the Department of Prime minister and Cabinet (DPMC) to ensure more strategic coordination, pan-Government collaboration, and effective working relationships with the private and research sectors.

Despite the branded ambitions for New Zealand to represent global leadership and clean-green themes', and its high exposure to geological risks it remains somewhat surprising that New Zealand Government has not followed the lead of Australia, African nations, the European Commission, China, Japan and other nations who have established centres for driving Digital Earth initiatives. This is especially surprising given New Zealand has previously played a key role in the Digital Earth through being the only nation to host two Digital Earth summits (NZ hosting both the inaugural Digital Earth Summit in Auckland (2006), and a held a subsequent Digital Earth Summit in Wellington (2012)). Like its 'clean-green' branding, New Zealand role with Digital Earth has been largely talk but little action of any substance. Examples of what other nations have recently

in advancing New Zealand's global standing in this critical digital infrastructure project.

The inaugural Digital Earth Summit was hosted in Auckland in 2006. This event was opened by Prime Minister Helen Clark and attended by over 500 scientists, technolgists and policy makers. There was also a strong youth contingent at the inaugural event. Since the Auckland Summit, Digital Earth events have been held annually in different countries and new initiatives launched to formalise the big-science and advance international collaboration.

> *"..The Digital Earth Summit is timely. There is a growing feeling that we are at an important cross roads of our planet's history.*
>
> *We are facing very challenging global issues, from the threat of change to our ecosystem, to a reduction in our biodiversity, the fast depletion of finite resources, and the rise of so many mega cities. Integrated data management can help us meet those challenges..."*
>
> **Prime Minister Helen Clark - opening speech at Digital Earth 2006**

The following photo shows some of the youth who participated at the inaugural Digtial Earth Summit in Auckland.

Last month (October 2019) Digital Earth was hosted in Florence as part of the Leonardo da Vinci celebrations (500 years since his death) and his pioneering contributions including the da Vinci Globe and his map projection system . In 2020, the Russian Academy of Sciences and space agency (Roscosmos) are jointly hosting the Digital Earth Summit in Moscow. The Australia Federal Government recently invested over A$40 million in Digital Earth Australia – this is an advanced technical project to build an open data cube to manage all modalities of satellite imagery captured across the continent. Digital Earth Africa was launched following last year's Digital Earth Summit in Morocco. Digital Earth has been deemed by the European Commission's Joint Research Council to be an important contribution to their Digital Agenda and the overall Europe 2020 objectives of smart, sustainable and equitable growth in the Union. Various Digital Earth initiatives including a Digital Earth Lab and hubs have been launched in Europe. The Chinese Academy of Sciences has established the Centre of Earth Observation and Digital Earth. Taylor and Francis (UK) now publish two scientific journals devoted to Digital Earth – The international Journal of Digital Earth (since 2008), and theBig Earth Data (since 2018).

Researching and innovating towards the frontier

Question 4:	Do you agree that the RSI Strategy should be focused on innovation at the "frontier" (creating new knowledge) rather than behind the frontier (using existing knowledge to improve the ways we do things)?
Question 5:	In which research and innovation areas does New Zealand have an ability to solve problems that nobody else in the world has solved? Why?
Question 6:	In which areas does New Zealand have a unique opportunity to become a world leader? Why?
Question 7:	What do you consider to be the unique opportunities or advantages available to the RSI system in New Zealand?
Question 8:	What RSI challenges are unique to New Zealand, that New Zealand is the only country likely to address?
Question 9:	What are the challenges of innovating in the public sector? How do they differ from those in the private sector?

Please type your submission below. If applicable, please indicate the question(s) to which you are responding.

Question 4:

Partially agree. Many of the government sponsored innovation initiatives in New Zealand tend to be focused on 'gadgetry' rather than the platform foundations and framework.

Question 5:

Digital Earth covers many fields of research. The challenge and opportunities come from contribtions to the policy and technology frameworks. The benefits and commercial opportunities will be derived from innovation on a common framework.

Question 6:

World leadership can be achieved by establishing New Zealand as an exemplar for Digital Earth. Leadership commences at home and not squandering once in a generation opportunities to

Question 7 and 8:

New Zealand's uniqueness comes from a blended scenario. For Digital Earth these should include:

1) Leadership – well informed
2) Literacy of concepts.
3) Higher Education

4) Innovation funding initiative to encourage collaboration between Government, Industry and research sectors
5) Global partnership for G2G relationships – leverage New Zealand's neutrality and small size is an advantage for becoming a 'Digital Switzerland' as Digital Earth emerges
6) Trusted science
7) Exemplar projects –
8) Transition the promotion from 'Middle Earth' to 'Digital Earth'
9) Policy melting pot. The Resource Management Act is a
10) Preparedness to be bold and prototype new paradigms of thinking, for example:
    a. A digital earth uniquely couples thermodynanmic model of the planet with social, physical and other environmental models. The digital twins (valued through veracity and truth) enabling this model could underpin a future monetary system (fiat, services, commodities). Refer to Global 4C - Monetary and Market policy for Climate Change (Winner of MIT Global Plan (2015))
    b. With advancement of Digital Earth, Meta-utilities will evolve as an Industry 4.0 organisation model to more effectively managing the digital twin operations and transactions of utilities. This will become necessary to ensure the necessary specialisation of data science skills and leveraging economies of scale. Mobility will soon join water, electricity, gas etc. to become a subscription service.

- Digital Twin – digital mirroring of the physical infrastructure
- Increasing complexity in managing digital utility
- Data Science – new levels of potential to optimise asset performance
- New 'smart' frontiers for utilities - smart homes, smart metering etc.
- Open Banking – rapid emergence of new fintech
- Pairing of complementary services – eg. sewer gas for power generation
- Improved situational awareness –spatial decision support with real-time events.
- Growing Cybersecurity demands –reducing catastrophic risks.
- Meeting 21st Century challenges - Climate change, extreme weather, sea level rise, aging infrastructure, epidemics, rapidly retiring workforce etc.
- Co-location Management –The collective knowledge of natural and built environments
- Economies of scale – accumulated benefits for improving the performance of all utilities (large and small, rural and urban)

See diagram below:

Some

Our key challenge – Connectivity

Question 10:	Do you agree that a key challenge for the RSI system is enabling stronger connections? Why or why not?

Please type your submission below.

Focusing on a framework and not the superficial 'gadgetry'. For example there is much hype around 'Digital Twin' and little mention of the enabling framework sometimes refered to as the 'Digital Thread'. A 'Digital Twin' can be likened to 'Bit Coin', and Digital Thread to the Blockchain. In fact there will be convergence of Digital Twin with cryptocurrency as the same issue apply across both for security, incryption, value building, and integrity. The framework needs to be effectively addressed by Government mandates, and policies.

Another, simpler and less mature parallel to consider a BIM Object as basic Digital Twin, and the BIM Object Library as its digital thread. Unlike the UK, Australian States and other nations the NZ Government has not been a driver for the adoption of Open BIM standards on major infrastructure projects.

Guiding Policy – Excellence

Question 11:	Do you agree with the definition of excellence presented here as the best thing possible in its context? Why or why not?
Question 12:	How can we achieve diversity within our research workforce? What are the current barriers preventing a diverse range of talent from thriving in the RSI system?
Question 13:	Do you agree that excellence must be seen in a global context, and draw from the best technology, people, and ideas internationally? Why or why not?
Question 14:	Do you agree that excellence is strengthened by stronger connections?

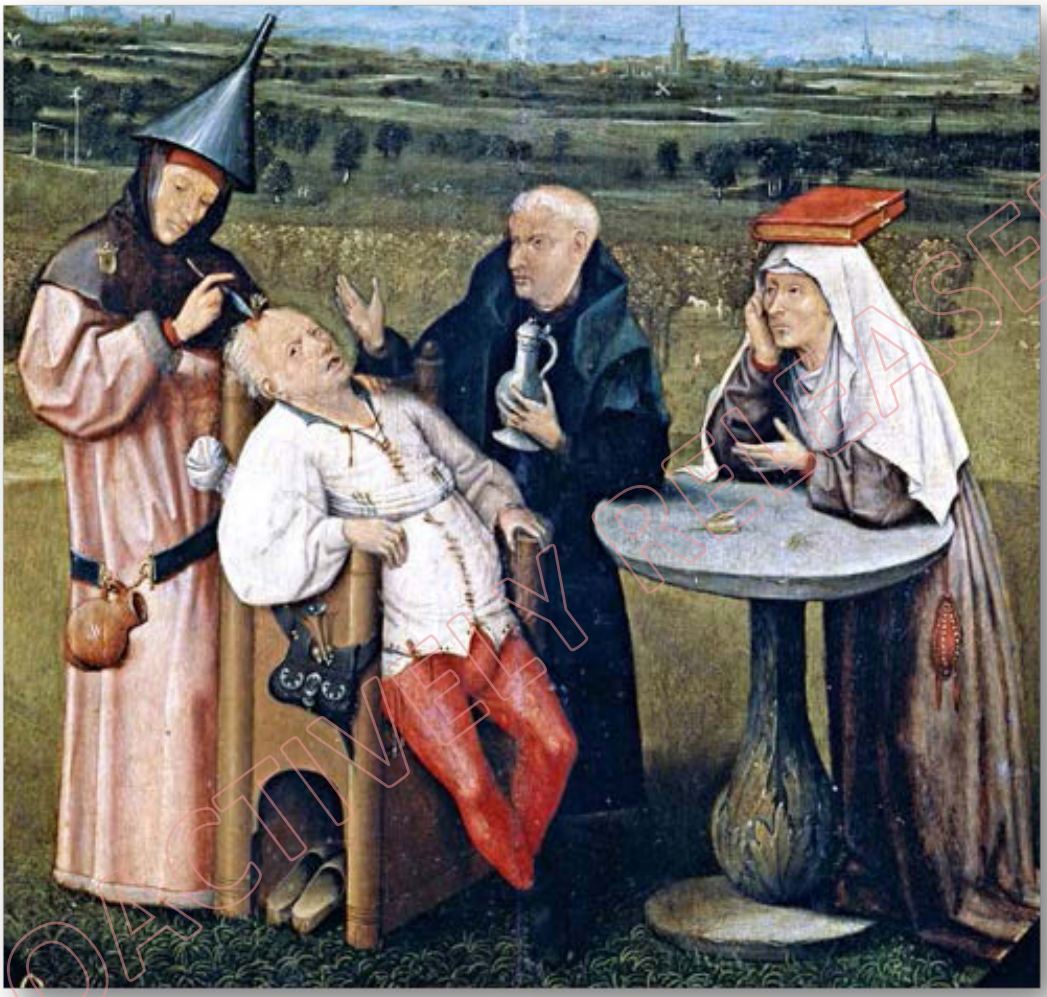
Please type your submission below. If applicable, please indicate the question(s) to which you are responding.

Question 11:

The structures and concepts of Government are just as subject to disruption as private sector and research. Excellence is specific only to the paradigm you are operating in, qualities that may be deemed as excellent, risk becoming an impedence in achieving excellence in a new frame of reference.

For example, many of our current regulations are supply-side in their approach. A Digital Earth will enable more demand-side thinking. For example instead of the current property tax regime (based upon Medieval law making and the Magna Carta), a Digital Earth approach would open opportunities for carrot-and-stick regulation models eg. a property owner would pay taxes based upon impermiability of the land surface, the health of the trees and their contribution to the carbon cycle, heavy metal runoff from a roof into the water systems, local sourcing of materials used during construction, operating utiltiies within the dynamic thresholds of sustainable resource supplies. In this futurist vision, a property owner may be allowed to remove any tree, but would have the onus of responsibility to at least match (within a determined period of time) the functional amenity of the replaced tree. The remote sensing technologies and sensors to achieve this are available today, but the governance model and policies are legacies of past centuries and clerical book keeping practices. Advances in the technologies will soon enable monitoring and measurement of impact to become near-real time.

The following painting by Hieronymus Bosch (c1450-1516) could be used to describe how brain surgery would be conducted if approached in the relatively unscientific manner urban planning is practiced today. Decisions are being made in ignorance of the sciences (eg. the impact of shifting billions of tons of ground water when Canterbury moved from mixed-farming to intensive dairy farming; the impact of sea level rise on the storm water systems of Auckland; long term issues arising from contamination; carcinogens generated from emissions etc.). Digital Earth would enabling the breakdown of silos limiting the transfer of knowledge, and would open up opportunities for more holistic thinking about the challenges, and would enable a 'language of progression' for improving accountability of our actions.



Guiding Policy – Impact

Question 15:	How can we improve the way we measure the impact of research?

Please type your submission below.

Question 15:

This has been answered in earlier responses.

Guiding Policy – Connections

Question 16:	Where do you think weak connections currently exist, and what are the barriers to connections at present?
Question 17:	What actions will stimulate more connectivity between parts of the RSI system?
Question 18:	How could we improve connections between people within the RSI system and people outside it, including users of innovation, and international experts, business communities, and markets?

Please type your submission below. If applicable, please indicate the question(s) to which you are responding.

Question 16:

There is need for a cohesive framework, international collaboration, and a common 'moon shot' vision for all disciplines to buy into. A Digital Earth vision addresses these with a compelling Why?, How ? and What?

Why – for survival of humanity

How – Establishing a strategic unit for Digital Earth – 'Digital Earth NZ' to lead and effectively enable the advancement and converence of technologies are driving a fourth industrial revolution (Industry 4.0). Culture, policies mandates, processes, people skilling, innovation frameworks etc. are all enablers. As is current technology advances in spatial resolution, learning, data provisioning, and graph data models.

What – Nano-satellites, hyperspectral imagery, location detection, Internet of Things, AI, Big Data Analytics, 3D printing, Virtual Reality/Augmented Reality, 5G, Fog/Edge Computing, Artificial Intellence, Ethical AI, In memory computing, data sciences etc. etc.

Question 17:

The next revolution in the built environment will be digital and not physical. There aere huge challenges to fund and build world-class infrastructure and housing to meet current and future demands while ensuring cities such as Auckland are attractive and liveable. Councils and the Government should not continue to squander opportunities to build this digital infrastructure. THis needs to be developed with international collaboration and within a Digital Earth framework. The recent history of New Zealand is littered with examples where the opportunity has been squandered – largely due to decision makers not appreciating the digital paradigm and contrained by the limited scope and measures of lifecycle performance. Examples include the City Rail Link (CRL) – unlike Brisbane's Cross River Rail project, the CRL pushed all digital modelling responsibilities back to the Alliance and had no vision, severely limited information requirements mandates and limited appreciation of the operational roles the data models could play post-handover. The CRL has missed its opportunity to become the digitial foundation to underpin a next generation Digital

Auckland. Part of the issues is institutional as Auckland Transport and Auckland Council are ill-equipped to deal with such data as it is not business as usual and transends organisational silos. Auckland Council has many CCO, but does not have a CCO specifically to address the needs of a Digital Auckland (in a Digital Earth context).

Similarly, in 2012 following the Christchurch Earthquakes, MBIE worked with LINZ and Councils on a visionary project called GeoBuild. GeoBuild was launched at the Digital Earth Summit in Wellington in 2012. One of the concepts was to centralise the planning approval so best use could be made of the growing scientific understandings and risks sites imposed. Also by centralising it would enable more agile ability to address the advances in building sciences, modular construction, nano-technologies etc. Geobuild initiative did not eventuate beyond the prototyping, as there were too many challenges to advance it as a pan-Government initiative (with the Councils). Hence, establishing a strategic unit for Digital Earth in the Dept of Prime Minister and Cabinet would follow a UK lead in BIM, and ensure a common focus while allowing convergences towards the most effective organisational models.

Question 18:

Embrace and lead Digital Earth initiatives and establish exemplarary projects.

Actions – Making New Zealand a Magnet for Talent

Question 19:	How can we better nurture and grow emerging researchers within New Zealand and offer stable career pathways to retain young talent in New Zealand?
Question 20:	How could we attract people with unique skills and experience from overseas to New Zealand?
Question 21:	What changes could be made to support career stability for researchers in New Zealand? What would be the advantages and disadvantages of these approaches?
Question 22:	Do you agree with the initiatives proposed in the Strategy to support and attract talented researchers and innovators? Are any changes needed for these initiatives to be successful? Are there any other initiatives needed to achieve these objectives?

Please type your submission below. If applicable, please indicate the question(s) to which you are responding.

Questions 19,21, 22

Arguably the three most disruptive technologies currently stand as Nano-Tech, Bio-Tech, and Spatio-Tech. Of the big three disruptors, Spatio-Tech, as demonstrated by the likes of Uber, has a propensity to drive deep fundamental societal changes. The Spatial Industry promises significant opportunity for New Zealand's economic futures.

There are four primary areas where Government can assist the market in achieving greater commercial success. First is in the development of skills, where Government supports the training of skills necessary for careers in the spatial industry. In Australia, the peak body for the spatial industry, SIBA, has augmented the Government's participation through initiatives such as Destination Spatial, and also sponsored the SIBA Chair of Spatial Information at Queensland University of Technology (QUT) to drive the development of research and courses necessary to meet the demands of the emerging spatial industry.

A second justification for Government intervention is the need to fixing a broken market. The spatial industry is a challenging landscape of policy, technology, and digital content. Each needs to be satisfied for innovation to advance the industry. In Australia, SIBA has established the Spatial Innovation Foundation (SIF) to help the industry better meet the next generation of core capabilities through more collaborative engagement between industry, government and academia. Examples of SIBA's SIF initiatives include the acceleration of an open 3D Cadastre.

SIBA has long been advocating the Government to focus investment at the delivery of core capabilities at the ideation phase, and not just the start-up and scale-up. SIF is focused at the ideation stage where the greatest innovation challenges occur, but the highest returns for the economy are promised. Former Ausrtralian Prime Minister Malcolm Turnbull said he wanted to usher in "an ideas boom". The total package involves an investment of $1.1 billion over four years which the prime minister said

will “incentivise, energise, dynamise” Australian industry.
Other market repair involves driving more risky capital into start-ups, trying to attract entrepreneurial talent to Australia and getting university researchers and industry to work more closely together.
The third role for Government in enabling a legal and compliance infrastructure for industry. This is the support of standards. IP, Copyright and other services to enable local and international interoperability.
The fourth intervention a Government can induce to stimulate an industry that of procurement. All three tiers of Government are major procurers of services and products of industry and research. In Australia, SIBA expressed concerns when State Governments’ sourced services from off shore businesses with no presence in Australia. The Government has an important role and responsible purchaser to enable sustained growth and nurture a productive environment for market led investment in innovation. SIBA has continued to advocate for improved procurement practices, and the introduction of agile contracts to reduce risks and improve outcomes.
To help drive critical initiatives in Australia, SIBA established the Spatial Innovation Foundation (SIF) as a vehicle to address the earliest stages of ideation of the core capabilities that define and disrupt the spatial industry. The Spatial Industry is a complex landscape of policy, technology, digital content, and organisational workflows. The Spatial Innovation Foundation (SIF) has been established by SIBA to serve as an infrastructure to more effectively achieve advancement of the spatial industry through innovation and development of core capabilities through exemplars. SIF achieves these though administering Knowledge Transfer Funds (KTFs) . SIF is an independent not-for-profit entity and administered at arm’s length by SIBA.
The input into SIF is a taskforce with a proposed initiative. This initiative will typically have been workshopped through an industry forums such as SIBA Knowledge Community and Pivotal. SIF dispense KTFs to deliver an initiative outcome such as a road-map, white paper, and in some cases a series of feasibility prototypes. The SIF process is reviewed by a SIF Industry Advisory Panel (IAP) comprising of experts in policy, legal, technical and other skills to help ensure the outcome has impact, is effective, and can sustain further development to become scalable and productive. SIF is focused on the stage of taking an initiative from ideation to an investable entity. This entity can then be invested in by business and or Government and might seed an innovation cluster. SIF stewards an initiative through the impeding labyrinths of policy, technology, digital content and organisational challenges. A current example of a current SIF initiative is the 3DQLD initiative for an open 3D Cadastre. The process faces a number of complex technical, data and policy challenges. The following diagram summarises the process:

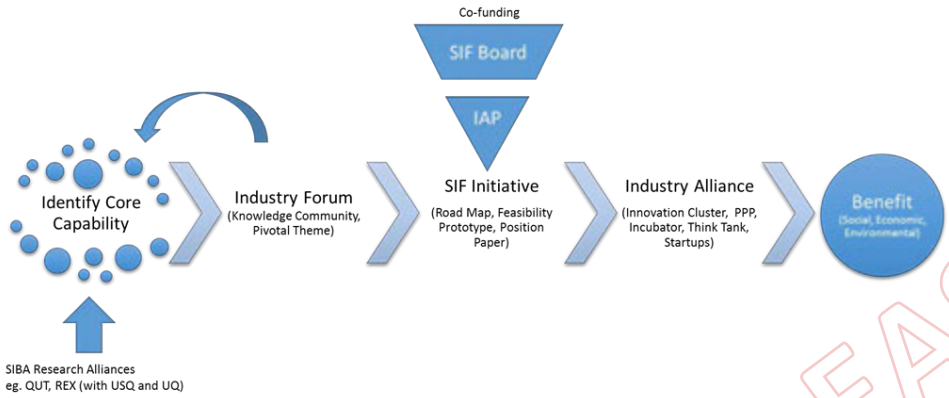


Figure 1 The Spatial Innovation Foundations Framework takes core capabilities to realisations societal benefits (Credit: R. Simpson)

Question 20:

Digital Earth is an international initiative. Developing New Zealands profile with exemplar projects and engagement with the international thought leaders at each event would contribute towards attracting the best minds to New Zealand's challenges.

For example the New Zealand Trade and Enterprise (NZTE) should consider ways to leverage from the fact that the inaugural Digital Earth Summit was held in Auckland in 2006, and invest in a traditional opening cocktail event to promote not only New Zealand's prowess in Digital Earth sciences and technologies, but also promote New Zealand products. This sponsorship would not be costly, but would have potential returns in the longer term as this initiative expands. The next Summit will be held in Moscow in September 2020 and hosted by the Russian Academy of Sciences and their Space Agency.

Of course there are other initiatives to attract NZ sponsorship, but the Digital Earth offers a potential way for branding the country as world leading knowledge economy committed to addressing the challenges of climate change and stewarding its natural and human made resources in a sustainable and accountable way,

Actions – Connecting Research and Innovation

Question 23:	What elements will initiatives to strengthen connections between participants in the RSI system need to be successful?
Question 24:	What elements will initiatives to strengthen connections between participants in the RSI system and users of innovation need to be successful?
Question 25:	What elements will initiatives to strengthen connections between participants in the RSI system and international experts, business communities, and markets need to be successful?
Question 26:	Are there any themes, in addition to those proposed in the Strategy (research commercialisation and international connections), that we need to take into consideration?

Please type your submission below. If applicable, please indicate the question(s) to which you are responding.

These questions have been answered previously.

9n December this year (2019) the ISDE is releasing the 'Manual of Digital Earth'. There was a soft launch for this manual in Florence last month at the Palazzo Vecchio (Florence Town Hall) in the fabulous Salone dei Cinquecento ('Hall of the Five Hundred'). See photos below. This first edition of the 1000 page manual is being published by Springer, the ISDE is making an open source version of this manual available as a free online wiki. It is anticipated this resource will help countries in the development of policies and curricula, and well as raising the general literacy around the technologies and concepts associated with Digital Earth.

The following slide is from the presentation given a the soft launch in Florence by the head of the European Commission Joint Research Council summarising some of the challenges to be addressed through this version (and future updates) of the Manual of Digital Earth.

I have been the editor and co-author of the chapter on Digital Cities. This chapter covers the advances in so-called 'smart' city initiatives, Connected Autonomous Vehicles (CAVs), the role of digital earth in the expression of places, and demand-side policies for driving optimal outcomes through scientific knowledge. In February 2020, a small group of us are gathering to write a feature paper on our vision for Digital Earth in the next 10 years. Our last 10 year vision was published ias a feature in the Proceedings of the National Academy of Sciences (PNAS).

Recommendation would be for New Zealand Universities to contribute to the wiki and future versions of the Digital Earth Manual and support the development of curricula, and reosurces to raise the literacy of Government policy makers and political decision makers around the rapid advances and potential for Digital Earth to New Zealand and other nations.

Actions – Start-up

Question 27:	How can we better support the growth of start-ups?
Question 28:	Do the initiatives proposed in the draft Strategy to support growth of start-ups need to be changed? Are there any other initiatives needed to support start-ups?
Question 29:	What additional barriers, including regulatory barriers, exist that prevent start-ups and other businesses from conducting research and innovation?

Please type your submission below. If applicable, please indicate the question(s) to which you are responding.

Please refer to earlier comments given above.

Actions – Innovating for the public good

Question 30:	How can we better support innovation for the public good?
Question 31:	What public-good opportunities should our initiatives in this area be focused on?

Please type your submission below. If applicable, please indicate the question(s) to which you are responding.

Question 31:

Strong leadership – converging the agency and Government powers towards advancement of Digital Earth in New Zealand.

Question 31:

There are many public good opportunities arising from Digital Earth. The first challenges for New Zealand should move up the Maslow Hierarchy of needs commencing with ensuring public safety through smarter designer and digital warning systems. Much work has been undertaken, but these could be embraced under the umbrella of Digital Earth New Zealand and get the momentum moving early.

Other obvious opportunities include mandate for open BIM standards and ensuring all infrastructure is built twice – first digitally, then physically based upon the consultation, insight and optioneering outcomes of the digital prototype. Once completed the digital model is used for operations and predictive maintenance etc. There is too much at stake for New Zealand not to lift its game and embrace the best practices seen in other countries today. Again, if these initiatives are undertaken in the name of Digital Earth New Zealand, it will help ensure collaboration and open standards are met.

Actions – Scale up

Question 32:	What is the best way to build scale in focused areas?
Question 33:	Do the initiatives proposed in the Strategy to build scale in focused areas need to be changed? Are there any other initiatives needed to build scale?

Note: see following page to comment on possible areas of focus

Please type your submission below. If applicable, please indicate the question(s) to which you are responding.

Question 32:

Sme nations are now establishing Digital Earth nodes for their research collaboration. This is akin to the Human Genome project.

Question 33:

The proposed Strategic Unit for Digital Earth mission could be to develop and demonstrate policy and practical insights that will enable the exploitation of new and emerging digital earth technologies, data and analytics to enhance the natural and built environment, thereby driving up commercial competitiveness and productivity, as well as citizen quality of life and well-being.
The proposed Strategic Unit for Digital Earth must be interdisciplinary by nature and not just a technical programme. It is bringing together industry, academia, and policy makers in order to consider the wider effects of the digital earth agenda on society and the economy. Identifying the questions to be asked in order to to establish how people want to steward the natural environement and use the built environment requires working with a multidisciplinary team, which we are starting to build – not just in Universities, but with other institutions nationally and internationally through open research and network calls for academia and industry.

Scale up – Choosing our areas of focus

For this draft iteration of the strategy, **we seek input on the selection of possible areas of focus**. We will consider establishing around five focus areas, but, depending on the eventual selection, are likely to introduce them over time, rather than immediately. In addition to the criteria set out in the Strategy document, we invite stakeholders to consider the following factors in their suggestions –

- The ambition of this strategy to focus efforts in the RSI portfolio at the global frontier of knowledge and innovation.
- Ways in which the RSI system can accelerate progress on the government's goals.
- The focus areas already determined by *From the Knowledge Wave to the Digital Age*.
- Work already underway where we are already seeking to build depth and scale in the RSI system.

The following areas could be a useful start, and are highlighted in *From the Knowledge Wave to the Digital Age:*

- **Aerospace**, including both autonomous vehicles and our growing space industry.
- **Renewable energy**, building on recent investments in the Advanced Energy Technology Platform.
- **Health technologies** to improve delivery of health services and explore opportunities in digital data-driven social and health research.

We invite comment on these suggestions and welcome input on other possible focus areas.

Please type your submission below.

Digital Earth should be the focus, and the framework brings together many of the enabling policies, cultures, technologies and skills that would advance innovation in other fields and industries as they emerge. Think of Digital Earth as a new renaissance enabled by Digital Twin capabilities.

Digital twins integrate internet of things, artificial intelligence, machine learning and software analytics with spatial network graphs to create living digital simulation models that update and change as their physical counterparts change.

Enabled by Digital Threads geometry, topology, behaviour (priors), semantics, systems are extracted from our physical and social world and represented as a digital twin

A digital twin continuously learns and updates itself from multiple sources to represent its near real-time status, working condition or position. A good example is Connected and Autonomous Vehicles and their demand for high definition maps (in addition to the robotics of the CAV).

Digital Earth is a global initiative to collate rich information and construct a comprehensive virtual representation of the planet that deepens understanding of the complex interactions of the physical world and the bearing these may have on our daily lives. The initial scientific work, with a focus on the physical aspects of our habitat, has revealed clearly the impact of large human populations and their activity. Scientists now call the 21st century the Anthropocene Era because their published

research shows that human activity is rapidly changing the ecosystem in alarming and unsustainable ways not experienced before in history. There is a need for substantial change in human activity.

However, although digital technologies are now highly advanced they are not yet well integrated into cultures globally. The warnings about over consumption, climate change and ecological degradation have been largely ignored or contested by people who have little knowledge of, or trust in, research via satellites and sensors, data management, modelling techniques and the reports of an elite group of scientists. Historically, scientific knowledge has not been shared with most people in ways that inform and include them enough to enable deep learning, cultural change and access to emerging opportunities It is therefore not surprising that democratically elected governments still subsidise and make war over fossil fuels, economic modelling usually externalises the ecological costs of human activity, and the opportunities afforded by emerging technologies and richer understanding of the complexity of our habitat are being ignored by most.

We live in an unprecidented and pivotal time, there is exciting potential for Digital Earth to become a enabling and critical project for humanity to grow a more widely shared and inclusive knowledge economy, in which many more people are collaboratively engaged in deep learning and participate actively to create a shared representation of their part of the planet, the value of the Digital Earth initiative will be understood and better supported globally.

An expanded global initiative, supported by shared and accessible technologies, to enable people to collaborate, apply their knowledge and use it creatively to make decisions, address issues that concern them and participate in sustainable economic activity would underpin the advanced scientific enterprise. One aim of such a project would be that the value of a richer understanding of the physical aspects of the planet, and its complex systems, is recognised by most people and enriched by parallel insights, understanding and evolution of the social and cultural aspects of a widely shared human consciousness.

Actions – Towards an Extended Vision Mātauranga

This section of the draft Strategy signals our intention to consult and collaborate further with Māori stakeholders to co-design our responses and initiatives. From that perspective, we consider the signals in the draft Strategy to be a start, rather than a set of final decisions. Nonetheless, we are keen on initial feedback in the following areas.

Question 34: Does our suggested approach to extending Vision Mātauranga focus in the right five areas? If not, where should it focus?

Question 35: How can we ensure the RSI system is open to the best Māori thinkers and researchers?

Question 36: How can we ensure that Māori knowledge, culture, and worldviews are integrated throughout our RSI system?

Question 37: How can we strengthen connections between the RSI system and Māori businesses and enterprises?

Please type your submission below. If applicable, please indicate the question(s) to which you are responding.

Digital Earth visioning is well aligned to concepts of Tangawhenua. Digital earth can be considered as discovering and sharing the deep stories about places and our engagmenet with these places.

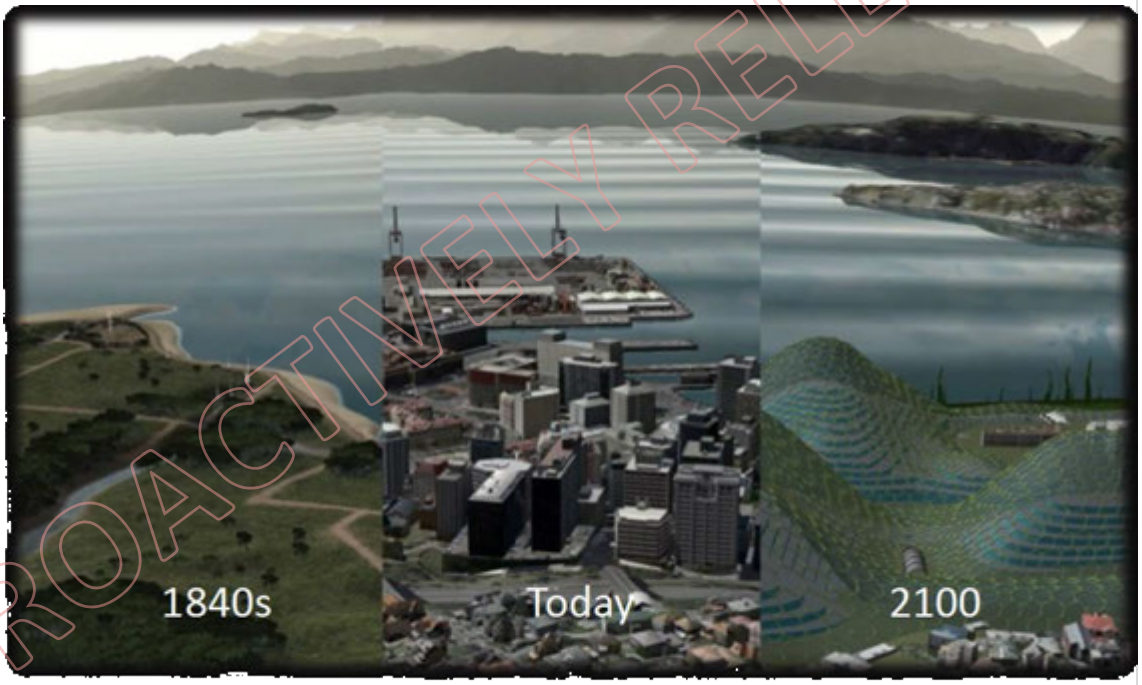
Digital Earth will become the most important scientific achievement of the 21st Century. It is a critical infrastructure for food security, water security, and a super-sense for enabling us to survive the Anthropocene.

Digital Earth can be considered extreme technology – satellites, rockets, quantum computing, peta-byte data sets, AI, and spatial technologies all brought together. It can also be viewed as the ultimate knowledge repository and amplifier. Digital Earth is a complex adaptive system like the things it is modelling and will play an important role in scientific evidence based planning of cities, and management of risks from natural disasters. Digital Earth can be considered as a framework for bringing together cultures, ideas, disparate initiatives and coordinating across organisational silos. Aside from the environmental and social merits, Digital Earth offers a path for building New Zealand's future knowledge economy and careers. It also offers a means for the expression of places in new ways through the arts (eg. Vivid in Sydney) and cultures (eg. Indigenous Australian languages are more topological than English and better at expressing places – Digital Earth can serve as a cultural bridge for explaining concepts. Some interesting Digital Earth projects in Australia include Immersive Heritage - A virtual experience of the Gadigal people - https://www.youtube.com/channel/UCrUF_HptsBFaOKKGHbTx9QA

For New Zealand to take full advantage and become a global thought leader it will be important for the Government to champion and help coordinate initiatives as part of a growing international collaboration. This may include establishing a strategic unit for Digital Earth in the Department of Prime Minister and Cabinet to help drive policy and investment agendas, and help to nationally brand New Zealand's collective prowess in

the sciences, innovation, arts and technology.

The 'Big:Data Changing Place' exhibition curated by myself (Richard Simpson) for the Reopening of the National Library of New Zealand was based upon Digital Earth themes. There was a lot of consutaltation undertaken with Iwi and the Port Nicholson Trust (local iwi) – especially around the recreation of the streams that once plied the Wellington landscape. One of the exhibits we developed (with Nextspace) had three large screens were used to interactively enable a fly over of Wellington to witness the changes of places over time. The historic models were outcomes of research into the national library archives, and also geological records from the Council, and agencies including GNS, and NIWA. Borelogs were studied to determine potential stream paths, along with historic drainage plans.



Interacting with 3D Wellington through three windows in time

Client: National Library of New Zealand for Big Data|Changing Place reopening exhibition – Meta Moto

THis exhibition opened in 2012 and ran through to mid 2013. The following Radio interviews relate to this exhibition and Digital Earth in New Zealand.

- Big Data – this series was based upon a series of forums charied by Kim Hill and hosted by the Royal Society of NZ on the themes of my exhibition (Big Data:Changing Place) curated for the reopening of the National Library (2012-13) https://www.rnz.co.nz/national/programmes/bigdata
- Kim Hill interview of renown US geoscientist Mike Goodchild (14 July 2012) https://www.rnz.co.nz/national/programmes/saturday/20120714
- Kim Hill interviews Richard Simpson (myself) (1 Dec 2012)https://www.rnz.co.nz/national/programmes/saturday/audio/2540236/richard-simpson

Actions – Building Firm Foundations

Question 38:	Do the current structures, funding, and policies encourage public research organisations to form a coordinated, dynamic network of research across the horizons of research and innovation? What changes might be made?
Question 39:	Is the CRI operating model appropriately designed to support dynamic, connected institutions and leading edge research? What changes might be made?
Question 40:	What additional research and innovation infrastructure is necessary to achieve the goals of this Strategy? What opportunities are there to share infrastructure across institutions or with international partners?
Question 41:	What elements will initiatives in this area need to be successful?

Please type your submission below. If applicable, please indicate the question(s) to which you are responding.

Current structures and policies are clearly inadequate and do not promote a culture necessary to advance Digital Earth in New Zealand. The failure to approach major projects such as the CRL in Auckland where weighting is given to a repurposed digital built environment, and the failure of MBIE's Geobuild are examples of why things are not working. Also there is an absence of references to Digital Earth and any of the emerging spatial data models in the Governments ICT strategy.

Also none of the current key Government roles including have Digital Earth responsibilities in their roles. These include Government Chief Digital Officer, Chief Data Steward, and Government Chief Information Security Officer.

A Strategic Unit for Digital Earth should be established in the Department of Prime minister and Cabinet (DPMC) to ensure strategically coordinated pan-Government collaboration with the private and research sectors in advancing New Zealand's global standing in this critical digital infrastructure project.

Digital Earth is an emerging big-science and can be considered the ultimate 'digital twin' of our integrated built, natural and social environments. As a knowledge amplifier and collective super-sense of the world we live in , Digital Earth is poised to emerge as the most significant social and scientific achievement of the 21st Century . It will become critical for ensuring food and water security and offers the best collective hope for effectively monitoring and addressing the big challenges threatening our survival - including climate change and epidemics.

Digital Earth as a Knowledge Amplifier

The International Journal of Digital Earth launched by the ISDE in 2006 has contributed significantly to the recognition of Digital Earth as new big science. If we consider the Digital Earth as a big science journey it becomes akin the international collaborations such as the Human Genome Project, the Physiome project, and if we consider it as being about building a platform infrastructure it can be considered akin to the international collaborations such as the Square Kilometre Array (SKA).

In April 2003, researchers announced that the Human Genome Project had completed a high-quality sequence of essentially the entire human genome. This sequence closed the gaps from a working draft of the genome, which was published in 2001. It also identified the locations of

many human genes and provided information about their structure and organization. The Project made the sequence of the human genome and tools to analyse the data freely available via the Internet.
In addition to the human genome, the Human Genome Project sequenced the genomes of several other organisms, including brewers' yeast, the roundworm, and the fruit fly. In 2002, researchers announced that they had also completed a working draft of the mouse genome. By studying the similarities and differences between human genes and those of other organisms, researchers can discover the functions of particular genes and identify which genes are critical for life.
The Project's Ethical, Legal, and Social Implications (ELSI) program became the world's largest bioethics program and a model for other ELSI programs worldwide.
Digital Earth is a significantly more complex, much larger scale challenges, and demands broader multi-disciplinary skillsets to deliver the project than the Human Genome project. Like the Human Genome project, the Digital Earth will yield more than just scientific outcomes. Concepts of nationhood and identity, and other socio-political and ethical outcomes will be subject to debate. Digital Earth will also become a scientific foundation for truth that future media empires may build upon and be benchmarked against. We are too early in the journey to guess at all the ramifications, but these will become increasingly important as Digital Earth advances in its journey.

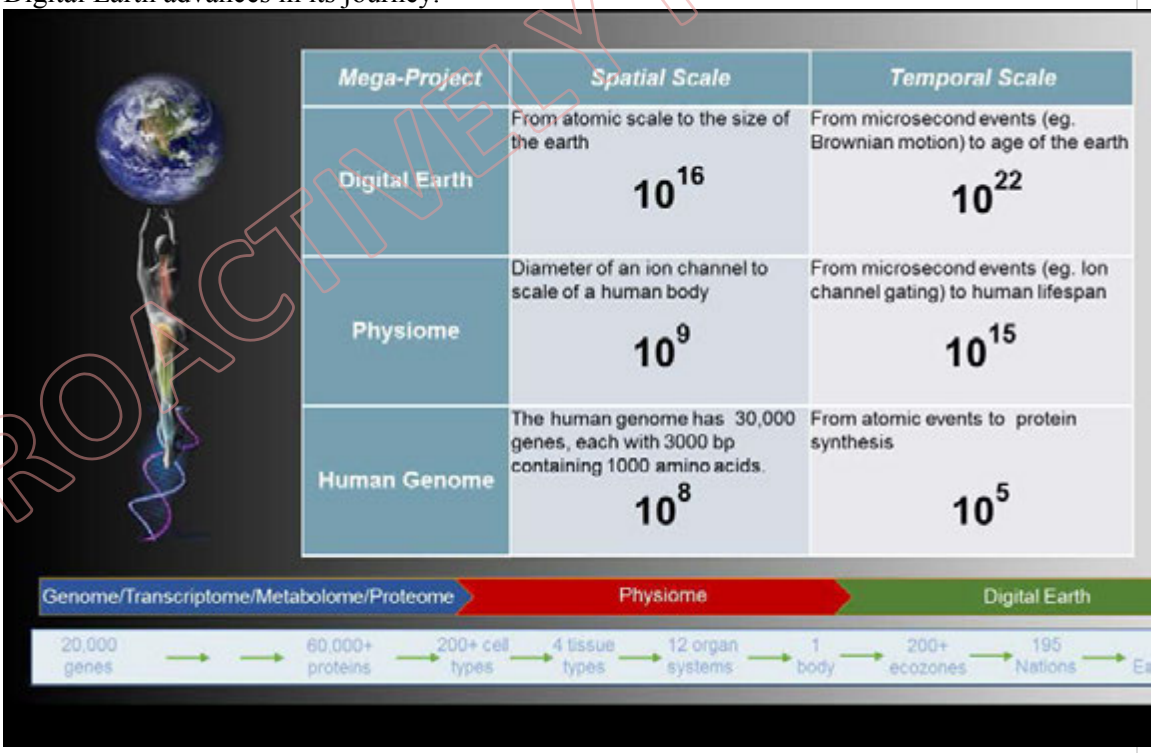


Figure 2 Digital Earth as a mega science project compared with the human Genome and Physiome projects (R. Simpson)

Digital Earth as a 'Collaboratory'

> *Obviously, no one organization in government, industry or academia could undertake such a project. Like the World Wide Web, it would require the grassroots efforts of hundreds of thousands of individuals, companies, university researchers, and government organizations.*
>
> *Although some of the data for the Digital Earth would be in the public domain, it might also become a digital marketplace for companies selling a vast array of commercial imagery and value-added information services. It could also become a*

> ***"collaboratory"--*** *a laboratory without walls — for research scientists seeking to understand the complex interaction between humanity and our environment.*
>
> *– Al Gore, The Digital Earth: Understanding our planet in the 21st Century*[1]

The essential focus of Digital Earth must be on building the most critical digital infrastructure for enabling a more viable future for humanity - the biggest big data, the fastest processes, most advanced space technologies, engaging visualisation are all part and parcel to this goal. More recently, it is recognised that spatial technologies and communication data can play a part in the human processes of understanding and responding to the need for change, monitoring the impact, and inventing successful applications of new technologies.

In addition to enabling important links with international scientific groups, Digital Earth Nodes, established throughout the world will also provide opportunities to use digital tools in applied science projects to resolve pressing issues such as: the enabling nations to meet sustainable development goals, and supporting the more local issues by directing Digital Earth advances to meeting challenges such as water and food security, protection of natural heritage (such as the Great Barrier Reef), better seward ship of natural resources, and disaster resilience. Effective digital systems also have serious potential for improving urban life and natural resource management, enabling business efficiencies, and enabling productive development in places such as Africa and Northern Australia.

Digital Earth as a public engagement and research programme

Public engagement programmes will help win hearts and minds and help drive local creative industries and thinking. Digital Earth in many respects will redefine the way we will see our planet and ourselves, and help access the hearts and minds of young people for a sustainable future. Digital Earth may well become the front and funding framework for critical climate change research.

To succeed in these lofty goals and deliver a critical enabling infrastructure for global prosperity, it is fundamental for the eventual realisation of these Digital Earth(s) for the ISDE to establish a Digital Earth Network of 'collaboratories' to engage populations across diverse cultures, researchers, leaders in government and the local spatial industry to these global initiatives. This network would be comprises of nodes (Centres of Digital Earth or CoDE nodes). This nodes will contribute to common Digital Earth efforts. They will integrate, advocate and engage researchers, industry associates and the broader community in projects to sustain health and wellbeing. It is important to note that these clusters of collaborating nodes are a network not a hierarchy. A focus on the ontologies of networked communication to engage human responses, and emerging techniques to understand them will also open new opportunities for transdisciplinary research and development.

[1] "The Digital Earth - Al Gore". digitalearth-isde.org. 1998-01-31

Actions – General

Question 42:	How should the Government prioritise the areas of action, and the initiatives proposed under each area?

Please type your submission below.

A Strategic Unit for Digital Earth should be established in the Department of Prime minister and Cabinet (DPMC) to ensure strategically coordinated pan-Government collaboration with the private and research sectors in advancing New Zealand's global standing in this critical digital infrastructure project.
Prioritisation of actions should generally be based upon Maslow hierarchy of needs (commencing with meeting the physiological and survival needs) and impact of initiatives to the environmental, social and economic wellbeing of New Zealand.
A starting place would be to define Uses (and Patterns of Uses, and Policy (and Policy Patterns) across Government. Then look at the data needs (and open standards) and its readiness to effectively meet these uses and policy needs. Systems of record, engagement and insight could then be explore and innovated to enable uses. There are emerging standards such as glTF making it now easier to pipeline mult-dimensional models to free open source browsers.
Other Countries have embarked upon Digital Earth initiatives based upon open source tools. A good example is the Dept of Prime Minister and Cabinet in Australia led the development of a Digital Earth based 'National Map'. This project was launched 5 years ago and is now the go to portal for information on Australia - https://nationalmap.gov.au/ . It was eveloped using open source (Cesium).

As it is open source and aligned to Digital Earth I assume Australia would be happy for New Zealand to adopt and adapt this to help fast track Digital Earth New Zealand. With this ready access to 3-D and 4-D above and below the ground data sets, and live sensor feeds, it will help enable innovative businesses in New Zealand to build value and create commercial opportunities and new digital market places.

General

Question 43:	Do you have any other comments on the Strategy which have not yet been addressed?

Please type your submission below.

A Strategic Unit for Digital Earth should be established in the Department of Prime minister and Cabinet (DPMC) to ensure strategically coordinated pan-Government collaboration with the private and research sectors in advancing New Zealand's global standing in this critical digital infrastructure project.