New Zealand's investment in MethaneSAT

Report to the Minister for Space
7 November 2025

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New Zealand invested $29 million from 2020 to 2025 in a US non-governmental organisation-led satellite mission to detect global (primarily) oil and gas methane emissions from space (MethaneSAT) and associated infrastructure and activities. This is a report prepared for the Minister for Space by MBIE, describing the investment design, decision-making and governance, with a view to informing future investments in the Space portfolio.

EXECUTIVE SUMMARY

In 2019, MBIE signed a Joint Declaration of Intent with the US-based non-governmental organisation the Environmental Defense Fund (EDF) and its subsidiary MethaneSAT LLC (MLLC) to pursue the MethaneSAT Mission. The primary objective of this mission was to detect global oil and gas methane emissions. New Zealand initially committed to investing $26 million in this initiative and associated infrastructure and activities, with the total budget growing to $32 million, and eventually falling back to a final spend of approximately $29 million. The New Zealand investment aimed to build domestic space sector capability through hosting the Mission Operations Control Centre (MOCC), to contribute to international climate science, and to explore the potential for applying the satellite's sensor to agricultural methane monitoring from space.

Between 2020 and 2022, the satellite and sensor were built, and mission operations were designed. The satellite was initially scheduled to launch in late 2022. However, launch delays, being common for space missions, resulted in launch taking place in early March 2024. After an initial period of commissioning activities by one of the US-based partners, BAE Systems, operations were transferred to Rocket Lab, which operated and monitored the satellite until March 2025, during which high-quality data was collected from the sensor including over New Zealand's pastoral farming systems. Rocket Lab remained agile and responsive to technical challenges with the satellite with a focus on ensuring the satellite remained safe.

In March 2025, satellite control was transferred to the satellite bus developer, Blue Canyon Technologies, to address these technical challenges. Contact with the satellite was lost on 20 June 2025, just before the University of Auckland was scheduled to assume long-term operations, contingent on successful review and the completion of technical milestones, via its newly established Mission Operations Control Centre (MOCC).

Despite the early termination of the mission, New Zealand achieved several outcomes aligned with the original rationale for investment. At the same time, there have been some public concerns around whether the goals of the New Zealand investment have been met. This report reviews the mission's origins, objectives, key decision points, governance and performance, and outlines key considerations for future space investments.

A key finding is there was no action – nor inaction – that New Zealand partners could have taken to prevent the loss of contact with the satellite. The report finds that the mission was

underpinned by a robust and well-considered setup, with decisions made through appropriate processes and well-documented. New Zealand has gained value from the initiative, including the establishment of a Mission Operations Control Centre (MOCC), access to scientific data, and a sustained contribution to global methane datasets. The project also provided valuable hands-on experience for those involved, contributing to national capability in space science and operations.

From a technical standpoint, while the satellite's failure is disappointing, the US-led risk management and advisory processes adhered to international practice. The innovative sensor technology performed exceptionally well; it was considered best in class. It appears that the issues that ended the mission may have originated from a failure in one of several systems on the spacecraft, but a definitive cause cannot be established. Importantly, the manufacturing and associated costs and risks were largely borne by the US partner, which made the partnership financially viable for New Zealand to join. A technical report has been prepared by the US side, with input from a New Zealand representative and has been released.

Public perception was challenged by heavily redacted responses to Official Information Act requests in the months prior to the mission ending creating the mistaken impression that earlier challenges on the mission directly led to the early termination. Redactions were largely on the basis of commercial confidentiality and information provided in confidence, supported by a Non-Disclosure Agreement that protected proprietary information and commercial interest, particularly between competing US and New Zealand firms involved in the production of satellites. These tensions are typical of complex international missions involving donor-funded entities, corporates, and governments. Additionally, while internal documentation was clear about the limited short-term climate benefits, earlier public messaging may have unintentionally overstated this aspect. Governance of the programme was sound, though complex, with multiple parties and contracts. Given the scale of the approximately $29 million investment, intensive monitoring and reporting are essential to managing risk effectively for missions of this kind.

LIST OF ACRONYMS AND TERMS

BAE Systems	Formed out of British Aerospace, acquired Ball Aerospace in 2024
Ball Aerospace	The company that provided the methane-sensing spectrometer for the satellite, later subsumed into BAE Systems
BCT	Blue Canyon Technologies. The Colorado-based company that designed and built the satellite, described as 'the bus'.
Catalyst	A fund run by MBIE focused on accelerating international science collaborations. The NIWA aspect of the MethaneSAT investment came out of Catalyst.
CDR	Critical Design Review. A technical review step in mission planning to validate the system design, ensuring it is ready to be built.
EAR	Export Administration Regulations. US regulations controlling the export of sensitive and dual-use civilian and commercial items.
EDF	Environmental Defense Fund. The US environmental advocacy organisation founded in 1967 with a particular focus today on combatting climate change
FDS	Flight Dynamics Systems. Analyses motion of a spacecraft and satellite in orbit.
ITAR	International Traffic in Arms Regulations. US regulations that control the export of defence and military technologies.
KSAT	Kongsberg Satellite Services. Norwegian company that provides ground network and earth observation services, using ground-stations from around the world including Awarua in Southland, New Zealand.
LeoLabs	US company that tracks and takes images of satellites and space debris in low Earth orbit
MethaneSAT	The programme set up to measure methane emissions from a satellite
MethaneAIR	A related airborne methane detection initiative that uses aircraft carrying the same (or similar) sensor to complement MethaneSAT's satellite data
MLLC	MethaneSAT Limited Liability Company. The subsidiary not-for-profit entity set up by EDF to run the MethaneSAT mission.
MOCC	Mission Operations Control Centre. Software and engineers who operate the satellite
NDA	Non-disclosure agreement. MBIE signed two NDAs: one with MLLC and the other multiparty with MLLC, Ball Aerospace and Rocket Lab, to enable the protected sharing between parties of proprietary information.
NIWA	National Institute of Water and Atmospheric Research, now part of Earth Sciences New Zealand
OAG	Operational Advisory Group. This was a technical group appointed by MLLC to oversee the operations of the satellite post-launch. (Similar to the TAG, pre-launch.) MBIE had its TAG representative continue onto the OAG.
RSI	Research, Science, and Innovation

SAG	Science Advisory Group. MLLC appointed this group to oversee the science data programme of the MethaneSAT mission. The SAG included an MBIE representative, a climate science expert.
SSIF	Science System Investment Fund – a fund run by MBIE. Most of New Zealand's MethaneSAT contributions were funded from the infrastructure subpart of SSIF
TAG	Technical Advisory Group. MLLC appointed this group to review the technical build of the sensor and satellite. The TAG included an MBIE representative, a former NASA engineer.
TCAS	Traffic Alert and Collision Avoidance systems
UoA	University of Auckland

BACKGROUND: HOW THE MISSION CAME ABOUT

The Environmental Defense Fund

The Environmental Defense Fund (EDF) is a US-based nonprofit organisation founded in 1967 by a group of scientists interested in using science to improve environmental policy and corporate practices regarding climate, ecosystems, and human health. Its approach is data-driven, solving critical environmental challenges through science, economics, and partnerships with the public and private sectors.

EDF has a long-standing focus on methane as a potent greenhouse gas. Methane is estimated to be responsible for roughly 30% of current global warming but there is a lack of comprehensive data on these emissions.

EDF established the project (mission) called MethaneSAT in 2018 to develop a satellite capable of high-resolution global monitoring, with the objective to quantify emissions from oil and gas operations and other sources, enabling more accountable climate action. The Mission needed partners.

Approach to New Zealand

The potential for New Zealand to be invited into a partnership role was first raised in 2018, with the initial approach delivered to MBIE through Rocket Lab connections, and facilitated by a New Zealander who was a former staff member at EDF. The sequence of events is outlined below.

- In 2018, an MBIE Policy Director attended a dinner with Peter Beck (CEO of Rocket Lab), during which Beck mentioned the opportunity related to MethaneSAT.
- Separately, a former communications professional at EDF (a New Zealander by this stage having returned to an unrelated role in New Zealand), approached the General Manager of the Science, International and Innovation Branch at MBIE.
- Following these informal approaches, MBIE initiated a series of more formal conversations in late 2018 and early 2019, including with EDF Chief Scientist Dr Steve Hamburg and MethaneSAT co-lead, Tom Ingersoll. These occurred on the margins of international meetings in Germany and in New York and served as an initial information-gathering phase.
- MBIE's initial conversations in Germany also included the CEO and the Chief Science Advisor of NIWA, who were both in Europe at the time.
- Ministers were informed of these discussions as they progressed, eventually resulting in Cabinet formally agreeing in June 2019 to a New Zealand investment of $26 million.

The details of budget allocations and Ministerial decision-making are laid out in a later section of this report.

The unsolicited approach from EDF to New Zealand in 2018 was considered a testament to New Zealand's growing international reputation as a new but serious spacefaring nation, a reputation stemming from the international success and profile of Rocket Lab. Related, and in response to this emerging industry in New Zealand, the New Zealand Parliament had the year before passed world-leading space legislation, the Outer-Space and High-altitude Activities Act (2017). The newly formed New Zealand Space Agency legislative and regulatory advisors were sought after at United Nations technical forums, for its innovative approaches

and case-studies establishing New Zealand as a responsible and values-based space nation. Additionally, New Zealand had niche reputations for the extent and quality of its atmospheric science research, extending to an existing collaboration between NIWA and NASA.

MISSION PLANNING: INTENDED OUTCOMES IDENTIFIED AND DOCUMENTED FOR THE MISSION

MethaneSAT global mission objectives

EDF's intended outcomes for the MethaneSAT Mission as a whole were to support the:

- high-resolution detection and quantification of methane emissions from oil and gas, and
- collection of data well-suited to support climate policy and emissions reduction strategies.

New Zealand partnership objectives

The Mission presented an opportunity for New Zealand to build capability and infrastructure in the domestic space sector. Building capability through joining an international space partnership mission was a pathway that had been consistently identified in international case studies as an important step in advancing capability in the domestic space sector, particularly for a small country in the early stages of establishing itself as a space nation.

In addition to the capability benefits, the Mission was a good fit with broader Government policy at the time, as it aligned with broader foreign policy objectives to contribute to global climate change mitigation efforts. New Zealand was also able to take the lead on developing an agricultural science data programme drawing on the broader set of methane data being collected.

The investment was thus positioned domestically as a flagship initiative that would:

- Make an important contribution to global climate change mitigation efforts and bolster New Zealand's international climate change credentials.
- Provide scientific data that can be used to support New Zealand's broader policy objectives around climate change and transitioning to a low-emissions economy.
- Support New Zealand researchers to be world leaders in using satellite data to detect agricultural methane emissions.
- Accelerate capability development for our space sector to support New Zealand being a sought-after international partner for similar missions.

New Zealand Government policy

The investment aligned with the Government's values-based economic priorities, as articulated in the 2017 Speech from the Throne (the Government's priorities for the upcoming Parliamentary term). These included:

- Climate leadership
- Net-zero carbon economy
- Environmental stewardship
- Development of innovative technologies.

Contemporary foreign policy alignment included a joint Foreign Affairs, Trade and Climate Change Cabinet agreement to pursue a global leadership role for New Zealand in climate change, for example contributing to flagship initiatives in sustainable space development and climate measurements.

How the partner/vendor was chosen

As noted in the previous section, EDF approached New Zealand with an opportunity and, following a 12 to 18 month process of due diligence, New Zealand said yes. EDF is a large and established organisation with an annual budget of USD 200–300 million. They have a substantial publication record in scientific research. The MethaneSAT mission was set up on a company structure, as the dedicated subsidiary MethaneSAT Limited Liability Company ('MLLC').

Prior to joining the mission, MBIE's technical assurance was based on EDF's work break-down structure and mission design approach in addition to the calibre and experience of the key technical programme leads with both commercial and government (NASA) space heritage. Furthermore, independent advisory groups, namely the technical advisory group (TAG) and the science advisory group (SAG) comprised eminent engineers and scientists from academia and industry. This included a former NASA Associate Administrator, a former NASA JPL director, and a former NASA JPL Chief Scientist. The SAG and the TAG were actively engaged in reviews of key decision and design aspects during the mission formulation. There was no reason to doubt the capability of these experts to make the procurement decision.

Before committing to MethaneSAT, MBIE identified 20 comparable current and planned international space missions in greenhouse gas reduction, including for example Japan's GOSAT, the European TROPOMI and several NASA missions. EDF was evaluated as the best option based on its world-leading precision of measurement capability in greenhouse gases. It also had the significant advantage of a relatively rapid timeframe, 36 months anticipated until launch, a desirable feature that had previously been identified in space sector strategy work: joining an existing international mission as an accelerated pathway into domestic capability development.

FUNDING

The New Zealand investment had three main elements, eventually amounting to just under $29 million (at one point projected at $32 million had the satellite not failed) : a $6 million Catalyst-funded science programme focused on agricultural methane; a $6 million contribution towards the US satellite technical operations build; $18 million to cover New Zealand's key role in the mission to build and operate the MOCC; and $1 million (budgeted for $2 million) to cover programme management costs. MBIE contracted Rocket Lab to build and initially operate the MOCC for up to one year after the satellite was launched ($12 million), after which the MOCC was intended to transfer to the University of Auckland ($4.1 million, budgeted for $6 million).

This investment was funded by $26 million (eventually $24 million) through the Cabinet-approved reprioritisation of Research, Science and Innovation portfolio funds, with the remaining $6 million (eventually $5 million) coming from the MBIE managed SSIF-infrastructure.

Table 1: Total New Zealand investment in MethaneSAT (2020 - 2025)

Organisation	Purpose	Investment (NZD)	Dates
Contribution to satellite build			
MethaneSAT LLC	New Zealand contribution towards Ball Aerospace and Blue Canyon Technologies delivery of operational procedures and flight software for satellite command and data handling	$6,000,000	2020 – 2024
Mission Operations Control Centre (MOCC)			
Rocket Lab	MethaneSAT MOCC scoping and establishment of MOCC for one year following launch	$12,000,000	2020 - 2025
University of Auckland	Long-term host and operations of the MOCC	$4,107,516*	2021 - 2025
Science Programme and MBIE Programme Management			
Earth Sciences New Zealand (formerly NIWA)	Hosting an atmospheric science programme	$6,000,000	2020 - 2027
MBIE	Programme management	$750,000*	2020 - 2024
TOTAL		**$28,857,516**	

(*) The original budgets for Auckland University and MBIE were $6 million and $2 million respectively. This meant a total budget of $32 million, with final spend reduced down to just under $29 million due to early loss of the satellite, and reduced spend on programme management.

MINISTERIAL AND CABINET APPROVALS OBTAINED

There were three key Ministerial decision points in the establishment phase: two papers to Ministers in September and December 2018, seeking a mandate for discussions, and the agreement by Cabinet in June 2019 to commit funds of $26 million of reprioritised funding to the project. These are described in more detail in the table below, with the three critical decision dates in bold.

Table 2: Ministerial and Cabinet Approvals establishing New Zealand's investment in MethaneSAT

Reference	Summary

September 2018
 	
Briefing to Ministers: Economic Development; Research, Science and Innovation
 	
Consulted agencies: Ministry for the Environment; Ministry of Foreign Affairs and Trade
 	
Reference: BRIEF 0876 18-19
 	
Title: "New Zealand involvement in a greenhouse gas remote sensing mission"
	Ministers agreed for MBIE to negotiate options for New Zealand participation in a space mission which would contribute to global climate change mitigation efforts.
	
	The primary focus of the international mission was to monitor oil and gas emissions; measuring agriculture emissions was not the main objective for EDF. New Zealand's proposed contribution would focus on agricultural emissions, leveraging the satellite's limited capability in this area.
	
	• The project would complement NIWA's existing strengths in data validation and calibration using ground-based sensors.
	• New Zealand aimed to contribute to one or more of the following: design, build, launch, or control of the satellite. Rocket Lab remained a potential launch partner.
	• The main objectives for New Zealand were:
	  • Building critical skills and knowledge in space and climate technologies.
	  • Establishing international credibility through participation in a global mission.
	• Developing a standalone national satellite of a comparable complexity was not feasible as this would exceed available resources
	• Partnering with an international mission was identified as the fastest and most effective approach to New Zealand achieving these objectives.
	• A potential collaboration with Harvard University, the Mission's science partner, could open up further research opportunities.
	• There was strong alignment with national priorities—climate change, skills development, and economic growth.

December 2018 Briefing to Ministers: Economic Development; Research, Science and Innovation; Climate Change	Ministers agreed that MBIE should express in-principle interest in participating in the MethaneSAT mission, led by the EDF. • Capability development remained a central priority. • Rocket Lab was still under consideration for launch, pending final satellite design. • It was acknowledged that the satellite would not be a substitute for New Zealand's agricultural methane measurement needs. • Participation aligned with New Zealand's values at the time—contributing to global climate action.

Reference	Summary
Consulted agencies: Ministry for the Environment; Ministry of Foreign Affairs and Trade Reference: BRIEF 1440 18-19 Title: "Greenhouse gas satellite mission – Discussions with the Environmental Defense Fund"	• MethaneSAT's key differentiator was its sensor's high pixel resolution, offering superior accuracy compared with other missions. • The sensor was to be tested prior to launch into space on a National Science Foundation aircraft. • Other satellite components were off-the-shelf technologies. • EDF was managing technical risks through experienced teams, advisory groups, and established processes. • MethaneSAT's capabilities were benchmarked against nine current and nine planned international greenhouse gas observation missions.
January 2019 MBIE Budget proposal	In early 2019, MBIE developed a MethaneSAT budget bid. This bid set out the key objectives, costs and benefits of New Zealand's proposed investment. The bid was not formally invited to progress through the Budget 2019 process, but instead underpinned the case for reprioritisation of RSI funds, later agreed to by Cabinet in July 2019.

June 2019
 	
Briefing to Minister : Research, Science and Innovation
 	
Reference: BRIEF 3153 18-19
 	
Title: "Package for reprioritising from the Research, Science and Innovation portfolio"
	Proposed a $26 million investment over four years.
	
	• Aimed to support New Zealand's participation in the MethaneSAT mission.
	• Funding targeted:
	  • Agricultural greenhouse gas remote sensing science.
	  • Mission control activities.
	• Positioned New Zealand to take a global leadership role in advancing the detection of agricultural methane emissions from space.
	• Enabled student and researcher involvement in MethaneSAT and other future space missions.
	• Framed as a time-limited opportunity aligned with climate science and space sector development.

July 2019 Cabinet agreement Reference: DEV-19-MIN-0191	Cabinet agreed to reprioritise $26 million from the Research, Science and Innovation portfolio to invest in New Zealand's partnership in the MethaneSAT Mission.
October 2019 Weekly report to Minister: Research, Science and Innovation Ref: BRIEF 0969 19-20	This was a short noting item, that New Zealand Space Agency officials held further discussions with EDF on the MethaneSAT partnership during the International Astronautical Congress in Washington DC.
November 2019 Event Briefing	The Minister for Research, Science and Innovation publicly announced New Zealand's decision to participate in MethaneSAT at an event in Wellington.

Reference	Summary
Ref BRIEF 1423 19-20	

GOVERNANCE

MLLC-MBIE partnership structure and governance

The mid-2019 Cabinet mandate enabled negotiation of formal agreements between MBIE and MLLC. These agreements describe how New Zealand's role and mission responsibilities would be structured, and how the international partnership would operate. Details from this agreement are summarised in the table below and included in full in the Annexes.

Table 3: Strategic collaboration undertakings between MBIE and MLLC

Document	Description
Joint Declaration of Intent October 2019 Within Appendix One	In October 2019, MBIE formalised its intent to participate in the mission by signing a Joint Declaration of Intent with EDF and MLLC (9 pages). This document confirmed the over-arching mission objective, strategic collaboration objectives and respective partner contributions for each of the signatories. This included the anticipated allocation of costs and responsibilities. The Joint Declaration also outlined the anticipated mission timeline, which was then used to inform the establishment of funding arrangements with New Zealand parties (as further described below). This Joint Declaration was also incorporated into the later Memorandum of Understanding. New Zealand was not responsible for the satellite components (including the bus), the launch, or the emissions sensor instrument. EDF's objective was monitoring oil and gas emissions; and New Zealand would explore the application to agricultural emissions research.
Multi-party Nondisclosure Agreement March 2020 Appendix Three	A multiparty non-disclosure agreement was signed in March 2020 between Ball Aerospace, MLLC, MBIE and Rocket Lab. It was to enable the protected exchange of proprietary information between all parties, pertaining to the remote sensing instrument and spacecraft bus requirements, ground system requirements, launch services (including launch vehicle and launch site requirements), and on-orbit commissioning services.
Memorandum of Understanding (MoU) December 2020 Appendix One	An MoU was signed between MBIE and EDF in December 2020 and confirms and expands in more legal detail on the October 2019 Joint Declaration of Intent. The MoU also sets out New Zealand's representation in the governance mechanisms which included a technical advisory group; science advisory group; and overall funders' steering group. The MOU also sets out the bilateral confidentiality arrangement between EDF and MBIE. The MoU was varied in April 2024 to reflect evolving partner responsibilities and timelines, and confirmed New Zealand's minimum commitment to the mission for the period of 'satellite launch plus one year'.

Document	Description
	The MOU with EDF was supported by a New Zealand Project Implementation Plan.
Project Implementation Plan (PIP) December 2020 Appendix Two	The PIP was commissioned by MBIE and prepared by an external provider, a former Jet Propulsion Laboratory employee living in New Zealand who was also MBIE's technical adviser on MethaneSAT. It outlines the technical baseline, structure of the project, and implementation approach of the New Zealand portion of the MethaneSAT mission. It informed key stages and components of the investment design. It proposes that a lessons learned process be conducted at the end of the programme. The PIP was finalised and published on MBIE's website in December 2020.

Steering Groups

MBIE established a MethaneSAT investment Steering Group, to oversee the establishment phase and contracting of the New Zealand investments. This Steering Group met regularly from 2020 to 2022 and approved the Project Implementation Plan, MOU and the various funding contracts with Ball/BCT, Rocket Lab, NIWA and the University of Auckland.

Individual funding decisions in the investment are delegated to MBIE. The Minister of Research, Science and Innovation was informed of key steps as these investment decisions were put into effect. A wrap-up briefing was provided to all interested Ministers in April 2021.

Table 4: Investment contracting – Ministerial oversight (2020 - 2021)

Reference	Summary
April 2020 Weekly report **Minister:** Research, Science and Innovation **Reference:** [BRIEF 2929 19-20]	A public webinar was held with 56 participants from the research community and private sector. It covered MethaneSAT's science objectives and included a Q&A session addressing technical, investment, and institutional queries.
April 2020 Weekly report **Minister:** Research, Science and Innovation **Reference:** [BRIEF 2998 19-20]	MBIE signed a $200,000 contract with Rocket Lab to develop an initial proposal for the MOCC.
May 2020 Weekly report Minister: Research, Science and Innovation	Applications were received for the MethaneSAT science leader role. The selection process was underway in collaboration with the US team.

Reference	Summary
Reference: [BRIEF 3275 19-20]	
April 2021 Briefing **Ministers agreeing:** Ministers of Research, Science and Innovation; Agriculture; Economic and Regional Development; and Climate Change were informed that MBIE had finalised the New Zealand parties delivering the MethaneSAT investment. **Reference:** [BRIEF 2021-3255] "Update on New Zealand's investment in the MethaneSAT space mission"	Update on New Zealand's investment in the MethaneSAT mission: • Rocket Lab was selected to build the initial MethaneSAT MOCC. • The MethaneSAT MOCC would be hosted long-term at the University of Auckland. • NIWA was selected lead the MethaneSAT science programme focused on agricultural methane emissions. • The MethaneSAT mission was confirmed as a significant and high-profile opportunity to bolster New Zealand's climate change credentials, particularly in addressing domestic challenges around agricultural methane. • MBIE, was working with MfE, MPI, and MFAT to maximise policy and advocacy opportunities arising from the mission. • International advocacy will be amplified by EDF's extensive global platform.
April 2021 Event briefing **Reference:** [BRIEF 2021-3268]	The Minister for Research, Science and Innovation announced the New Zealand partners and their roles in the MethaneSAT Mission at a public event in Auckland.

TECHNICAL REVIEW

Following the loss of the mission, MLLC conducted an anomaly investigation analysis. A anomaly investigation report is attached to this report. The investigation concluded that the anomaly was likely a result of an event impacting one of two systems, either the flight avionics unit which executes commands, maintained attitude and controlled communications, or the electrical power subsystem responsible for powering other components, subsystems and payloads of the satellite.

MISSION EXECUTION: RESULTS AND OUTCOMES ACHIEVED DURING THE ACTIVE PERIOD OF THE MISSION

The MethaneSAT satellite launched successfully in March 2024. In June 2025, while being operated by US-based mission partners, the satellite lost contact rendering it likely unrecoverable. The loss was confirmed 2 July 2025, and the mission was stood down. The failure occurred just days before New Zealand was scheduled to take over mission operations, cutting short the opportunity to fully realise the mission's benefits. MLLC convened a Failure Review Board which conducted a formal investigation with briefings to the Operations Advisory Group (a successor to the Technical Advisory Group) that included a New Zealand representative. However, ITAR and EAR restrictions limited the extent of New Zealand participation (New Zealand's OAG member is a United States citizen but must be physically present in the US to call-in to briefings).

Since inception, New Zealand has achieved some results, and progress has been made across all MBIE's investment goals.

Science programme

The MethaneSAT science programme brought together methane and remote sensing researchers from Earth Science New Zealand (formerly NIWA) the New Zealand Institute for Bioeconomy Science (formerly Manaaki Whenua Landcare Research), the University of Auckland, the University of Waikato, and Victoria University of Wellington. Its primary aim was to assess the satellite's capability to map agricultural methane emissions.

MethaneSAT conducted 97 measurements over diverse agricultural regions globally, including 13 over New Zealand. In parallel, the MethaneAIR airborne instrument surveyed over 200 agricultural sites in North America. Early findings revealed significant differences in methane emissions between intensive North American systems and New Zealand's predominantly pastoral systems—highlighting potential gaps in current emissions reporting methodologies.

Progress has been made in data modelling, with the transfer of advanced algorithms from Harvard, EDF, and the Smithsonian to New Zealand researchers. These include:

- A wavelet algorithm for image denoising,
- A retrieval algorithm for methane concentration estimation,
- The divergence integral algorithm for plume-based emissions,
- An inverse model for diffuse emissions.

New Zealand scientists are also adapting their own modelling approaches particularly suited to New Zealand topographies.

Although the early termination of the mission means no new data will be collected, the existing dataset can be analysed through to the end of 2025 and provides a strong foundation for ongoing agricultural emissions analysis.

The New Zealand MethaneSAT science leader was invited to join the Scientific Advisory Board for a European Space Agency project on agricultural methane and pollutant monitoring. Stemming from the MethaneSAT work, the team is also contributing to a Ministry of Primary Industries/Ministry of Foreign Affairs and Trade-endorsed Global Research Alliance project that integrates farm-level data, satellite observations, and machine

learning to map emissions at higher resolution—potentially transforming how emissions are quantified at the farm scale.

Capability-building efforts include two PhD students undertaking placements at Harvard, and a postdoctoral researcher from the University of Bern now based at the Ngāi Tahu Research Centre at the University of Canterbury.

Infrastructure and Capability

Rocket Lab was contracted by MBIE to develop the initial MethaneSAT MOCC in New Zealand, as it was determined to be the only organisation with a New Zealand base at the time with the necessary capability and expertise to deliver this within the timeframes required to meet New Zealand's commitments to the MethaneSAT programme. Rocket Lab worked alongside the US MethaneSAT mission team to develop and operationalise the MOCC, ensuring safe and compliant procedures for the eventual transition of satellite operations to New Zealand. As an integral part of the development team Rocket Lab contributed the following:

- Defining and refining MethaneSAT mission operations requirements and mission workflow in participation with the Mission Systems Working Group (MSWG).
- Developing mission operations software and architecture.
- Establishing ground station, tracking and collision avoidance (TCAS) and Flight Dynamics (FDS) system capabilities and relevant support contracts to support operations.
- Planning and coordinating the MOCC development and infrastructure requirements, including IT and physical security.

Rocket Lab supported the mission for the period of launch + 1 year (March 2024 to February 2025) with the following outcomes:

- Conducting daily mission operations to include science data collections, station keeping, sensor calibration manoeuvres, safe-mode recovery and all necessary support and coordination for the overall mission safety
- Planning and coordinating the MOCC development and infrastructure requirements, including IT and physical security.
- Providing operations training documentation and training of personnel.
- Preparing for the transition of the MOCC to the University of Auckland, including the development and validation of the plans, procedures, and operator skills to conduct MethaneSAT mission operations safely and efficiently.

The University of Auckland's Te Pūnaha Ātea – Space Institute (TPA-SI) was contracted by MBIE to act as the long-term MethaneSAT MOCC host. In August following loss of the mission, the contract was concluded by MBIE. Despite the early conclusion of the contract, this investment has provided critical infrastructure and capability for New Zealand's space sector. Funding has supported:

- Construction of a physical MOCC at TPA-SI.
- Recruitment and training of MOCC personnel.
- Engagement in institutional planning for training and facility management.
- Development of course offerings in space and aerospace engineering.
- Outreach and networking to identify future space collaboration opportunities.

It was anticipated that the full impact of New Zealand's investment in the MOCC would be achieved once the satellite was handed over to the University. However, some progress towards the overarching goal of increasing and broadening space sector capability has been made by both Rocket Lab and the University. A key rationale for seeking a university partner as long-term MOCC host was to support direct student exposure to satellite operations, enabling structured coursework and hands-on training. Although the original hands-on training programme was scheduled to begin once the TPA-SI assumed control of MethaneSAT, delays in handover prompted MBIE to encourage interim capability-building activities. In response, TPA-SI developed a Spacecraft Operations Programme from May to July 2025, supporting up to eight students in practical training using the university's own newly launched TPA-1 satellite.

EVALUATION AND FUTURE PLANNING: LESSONS LEARNED AND APPLICATION TO FUTURE VENTURES

The MethaneSAT investment included some complex design characteristics and choices that may inform future space policy and investment decisions. These span technical, programmatic, governance and communications domains. This section of the report examines what went well overall and addresses some specific issues that have been raised as potential concerns.

The satellite technology

Procurement and risk management

The satellite procurement process, led by EDF, followed rigorous industry standards. A five-month design study was undertaken to evaluate the MethaneSAT design, supported by EDF, Harvard, the Smithsonian Astronomical Observatory (SAO), and the MethaneSAT TAG. Focus was placed on the instrument as the most novel component required for an effective system. The TAG supported the vendor vetting process including reviewing proposals, site visits to validate risk and performance of vendors, and conducting independent analysis to inform the selection of appropriate partners and pathways to deliver the mission. A longlist of 20 vendors was identified and two were invited to compete for construction of the satellite. In September 2019 MLLC signed a contract with Ball Aerospace to design and build the sensor.

Following discussions with Ball, MLLC elected to identify a separate vendor for the satellite bus. An RFP was issued to nine organisations for a commercial bus and the EDF selected Blue Canyon Technologies (BCT), an established small satellite provider. The selection of BCT was made based on proposed cost and delivery schedule. The satellite's 'bus' was not considered the innovative part of the mission: the innovation lay in the sensor.

In January 2020, the MethaneSAT mission moved into a critical design review (CDR) phase that was completed in June 2020. The phase began with a three-day Preliminary Design Review (PDR) involving Ball, Blue Canyon, EDF, and 23 members of the MethaneSAT technical and science advisory groups. Upon successful completion of the review, the team determined that the baseline designs met or exceeded expectations, with no unexpected issues for this stage of development.

At that time, a "tiger team" from within the TAG was tasked with reviewing the design in search of potential high-impact improvements. Their recommendations for improvements were made by the end of April 2020, and were incorporated into the integrated design (instrument and bus) by completion of CDR. A formal configuration control board made up of leadership from key project participants and chaired by MLLC's SAG chairman Joe Rothenberg, former director of NASA Goddard Space Center, approved any changes made to the design after CDR.

Rocket Lab was integrally engaged in the Mission Systems Working Group as a collaboration to build the mission operations architecture, interfacing with Harvard, BCT, Ball, MLLC in addition to integrating third-party providers of key services such as ground stations (the Norwegian company, KSAT) and collision avoidance (US-based company, LEOLABs). MBIE's technical advisor also sat in on these weekly meetings. MBIE was kept informed of technical issues from the advisor, reports from Rocket Lab and MLLC's weekly "top ten" summary of issues. Any issues were resolved directly by MLLC as managed by the mission manager to

delegate to the responsible technical entities. New Zealand and MBIE were not directly responsible, nor in a technical decision making role in aspects of the bus or the payload per the mission work-breakdown structure.

The key high-level decisions as to payload and bus providers (Ball and BCT respectively), occurred early in the mission development and soon after New Zealand's decision to partner. The rationale was sound and New Zealand (MBIE) was cognisant of MLLC's use of industry-standard engineering processes and protocols to manage mission risk. BCT while relatively new, was founded by reputable experienced engineers who were former Ball employees. MLLC and the TAG consulted and reviewed BCT's capability rigorously but MBIE and the New Zealand representatives were fire-walled from the in-depth reviews of Ball and BCT in the selection process due to stringent ITAR and EAR restrictions. There was no option for New Zealand to participate in any in depth technical review.

Technical performance

The satellite failure occurred in a largely, but not quite, 'off-the-shelf' bus, adapted for a specific purpose. Some of the sub-components, such as the thrusters, had limited flight heritage and some issues did arise.

MBIE managed its contract with MLLC by linking payments to the delivery of technical milestones. Payments were withheld when delays occurred in the achievement of agreed milestones and were only released following technical assessment and milestone verification.

Post-launch, issues with the thrusters resurfaced. MBIE worked with MLLC to establish technical milestones that made the transfer of mission control to New Zealand contingent on thruster performance. At the time of the satellite failure, this milestone was still undergoing validation.

In contrast, the innovative sensor performed best in class.

Comment: Depending on the circumstances, there could be value in conducting an additional independent technical review of satellite design choices before committing to future missions. That said, given the calibre of the US-based independent review team involved in this mission, it is unlikely that a second review would have reached different conclusions. There is no evidence that New Zealand's more direct involvement in the choice of the satellite, would have resulted in a different procurement decision. For example, the bus supplier selected has delivered spacecraft for other successful missions including NASA's PRE-FIRE which launched from New Zealand in 2024.

Additionally, by the time the funds had been secured through Cabinet in mid-2019, most design and procurement choices had been made. There was no reason to believe there were particular risks associated with the design and procurement process any different to those typical to any mission. Attempting to renegotiate or delay the design at that stage would have likely jeopardised New Zealand's opportunity to participate, and it would have been unusual to request detailed technical information before entering any kind of partnership arrangement.

New Zealand bought into only a part of the satellite and was a minor party in the overall cost of the satellite itself, less than 5% of the build and launch total cost. This was by design as

New Zealand's focus was on the MOCC and science programme activities conducted in New Zealand.

Potential sovereign mission development

Future investments in a potential sovereign space mission in New Zealand would require more direct involvement in a formal and comprehensive technology procurement process. This would be particularly important if MBIE were to fund a large-scale operational mission (given the scale of the likely investment). However, this would require careful consideration of trade-offs. Directly managing the procurement process does not necessarily reduce risk; it may increase complexity and cost and would require significant technical capability.

Similar considerations would apply to a full sovereign in-country build. Very early on in the mission's exploratory phase, there may have been an option for New Zealand to bid in to build the MethaneSAT satellite, and similarly to launch from New Zealand. Launch from New Zealand was ruled out once the satellite had been designed, as the payload's size, weight and power pushed it beyond current New Zealand launch capacities. In either case, the opportunities here would need to be weighed against the increased cost, and the fact that New Zealand would also bear a larger portion of the risk.

Managing complexity in multi-partner missions

The MethaneSAT mission involved a large number of partners across different jurisdictions, each with distinct contractual and operational relationships. On the US side, Ball Aerospace (Ball) and BCT were contracted to MLLC as manufacturers of the methane sensor and the satellite bus respectively. On the New Zealand side, Rocket Lab and the University of Auckland were contracted by MBIE to host the MOCC post-launch.

While MBIE and MLLC had an overarching MoU, there were no direct contractual relationships between MLLC and Rocket Lab, or (until later) with the University of Auckland. Additionally, commercial competitiveness issues made it more complicated to ensure maximum information sharing between Rocket Lab, Ball and BCT. While export control issues added a layer of complexity, the required licenses were in place on the US side to allow for flow of required information.

Comment: While this arrangement allowed New Zealand to participate in a sophisticated international mission at a relatively modest cost, the complexity made it harder to manage when challenges arose during the mission. Future missions should consider the number and structure of partner relationships. Where possible, direct contractual and information-sharing arrangements could be established between all key technical contributors. This could improve coordination, and support more effective issue resolution when challenges arise. It would also mean New Zealand would have to invest a greater share of mission costs, and limit the involvement of the full range of public and private organisations that featured in MethaneSAT with implications for achieving the overall mission outcomes.

Public expectations and communication

Information access and contractual design

The multi-party setup also complicated information sharing with the public. MBIE's commitments under the required NDAs and the exchange of other information under obligations of confidence enabled technical parties to access proprietary information, but it led to significant redactions when information was sought under the Official Information Act (OIA). This impacted perceived transparency around the mission.

Comment: For future projects, ensuring formal agreements provide MBIE sufficient freedom in the partnership to disclose information about how the mission is going will be critical to maintaining public trust. It is critical to work with partners and systems that support the level of openness and transparency expected in public sector collaborations. Establishing a domestic advisory group could also help improve stakeholder confidence and oversight.

Setting realistic expectations

Future missions could set realistic public expectations from the outset. Scientific research and innovative technologies have inherent uncertainties, as they are experimental, and the outcomes cannot be known at the start. Furthermore, space activities are risky – missions often fail or end prematurely. In the case of the MethaneSAT mission, the data collection and early results have been promising. The technical failure, while disappointing, occurred in components outside of New Zealand's control and within the bounds of accepted risk in space missions.

There is always going to be uncertainty in flying a space mission. This applies not only to ultimate outcomes but also to choices that are made when challenges arise. Reasonable people can reach different judgements faced with the same situation.

While written advice was clear on the scope and limitations of the mission and New Zealand's role, early public communications tended to emphasise the climate benefits—particularly in relation to agricultural methane. For example, public messaging often highlighted contributions to the global climate mission and application to agriculture, ahead of New Zealand's development of space capability. This framing influenced how the investment was perceived externally and may have contributed to misaligned expectations about what the mission could realistically deliver.

Comment: Setting and publicly declaring success criteria for New Zealand's mission contributions would strengthen transparency for missions in future.

Governance and strategic oversight

Establishment documentation and decision-making

The establishment phase was detailed, well-resourced, and the documentation meets required standards.

While the project was continuously resourced within the Ministry, the level of resourcing allocated to the project changed with evolving requirements for administering New Zealand's partnership in the project, in addition to wider portfolio priorities. Following the selection of New Zealand partners to the mission, resource focused primarily on MBIE's core responsibilities for coordinating activities and contract administration. Dedicated resource

was not always available to advance the broader purposes of New Zealand's involvement in MethaneSAT, i.e. to catalyse capabilities, partnerships, and research.

Comment: Taking a risk-averse approach by setting up dedicated monitoring requires resourcing which is subsequently unavailable for other priorities. Additional resourcing to monitor and ensure the full scope of delivery anticipated in each subcontract was being achieved could have supported the investment's overall impact. This would have had relatively limited impact in this case given the satellite suffered a technical failure, but it may have enabled additional impact while the mission was active.

Steering groups

MLLC ran a Steering Group for all funders that met quarterly for the entire period of the Mission. MBIE was represented in a non-voting capacity initially at the General Manager level, and later the Manger level.

New Zealand actively raised several issues through the Steering Group, including for example at a key session in late 2022:

- Science Programme: Emphasising the need for a baseline level of methane emissions data from agricultural sources to be embedded in mission operations planning to support the New Zealand science programme.
- Agricultural Data Targets: Proposing a formal discussion to agree on minimum agricultural data targets for the MethaneSAT mission and encouraging consensus on this point.
- MethaneAIR Campaign: Registering interest in ensuring a reasonable level of agricultural monitoring was included in the MethaneAIR campaign.
- Spacecraft Bus Delays and Cost Implications: Raising concerns about delays in spacecraft bus development, which risked impacting the planned launch dates. Further delays would have cost implications for New Zealand partners, and MBIE sought discussions on how potential overruns would be managed.

While New Zealand's engagement in the Steering Group was active and constructive, it was also time-consuming and required dedicated resourcing to maintain influence and follow through on key issues. This was not always available, resulting in some missed opportunities to advance the objectives of the missions.

Comment: Future missions should ensure governance structures are adequately resourced, with clear role definitions and continuity mechanisms. MBIE should strengthen its capacity to monitor contracts, enforce deliverables, and maintain strategic oversight throughout the mission lifecycle. These arrangements do not guarantee mission success, but they support achievement of broader benefits from the mission, and effective planning and management of cost and schedule reserves as missions progress.

Role clarity and resourcing

While MBIE had strong engagement at a working level, programme management was under-resourced, despite initial plans for a senior leadership role to provide strategic direction and coordination. This option was initiated with interviews for the role conducted but the COVID lockdowns resulted in no hire being made nor possible. While MBIE had consistent representation across mission-related groups (e.g. TAG, SAG, and the joint project working

group), the project spanned more than six years and so governance and oversight were often supported by individuals with limited access to relevant background knowledge.

Future initiatives could ensure that governance structures are clearly defined and maintained throughout the project lifecycle to support strategic oversight, risk management, and accountability. There was an overreliance on institutional knowledge held by relevant individuals in MBIE, introducing key person risk. To address this in future, knowledge should not reside solely with individuals; it must be systematically captured and shared to support continuity and resilience.

- Complex initiatives require more resourcing than was allowed for in this case - not just at the working group level but also at a governance level.
- When initiatives span multiple teams with differing priorities and responsibilities, shared accountabilities and oversight mechanisms are essential to ensure alignment and effective collaboration.

Comment: Such an approach takes additional resource and a clear prioritisation relative to other activities. It also requires people with a range of expertise and experience in space missions which requires more opportunities to develop this experience in New Zealand as well as attracting it from overseas for further missions.

Contract monitoring and financial controls

MBIE managed three funding agreements, supported through the SSIF Infrastructure appropriation, related to the MOCC. These agreements were each structured slightly differently, due to contract holder requirements and the aims of the contract.

Agreement between MLLC and MBIE to fund Ball Aerospace and BCT deliverables

The objective of this agreement was to ensure BCT and Ball had developed the required technical documents to enable Rocket Lab to operate the satellite post-launch. Payments were linked directly to milestone delivery which proved effective for managing risk in a complex mission. However, challenges arose due to the constraints of annual financial cycles. Multi-year funding allocations would better support milestone-based contracts, allowing payments and deliverables to align with evolving mission timelines.

Comment: MBIE should retain milestone-linked payments for complex investments and should explore multi-year appropriations and flexibility.

Agreement between Rocket Lab and MBIE

Rocket Lab was selected as the initial MOCC host and prepared a budget and cost estimate for this role. A SSIF Platform agreement was used as the contract vehicle, and payments were made quarterly, in advance. Given launch delays, MBIE had to negotiate a no-cost contract extension to retain Rocket Lab as a key mission partner. MBIE's ability to monitor any contract underspend was limited once all funds had been disbursed.

Agreement between the University of Auckland and MBIE

The University of Auckland was selected as the long-term MOCC host and a SSIF Platform agreement was used as the contract vehicle. Payments were made monthly, in advance. Given launch delays, MBIE had to negotiate two contract extensions, each involving the allocation of additional funds, to ensure key personnel were retained.

Comment: In future, MBIE may consider linking contract payments to delivery of work programme milestones. This would allow funding to keep cadence with the mission and would enable better flexibility and leverage if delays are encountered. This approach may be limited by Treasury's rules around appropriation management across financial years. It would also be supported by adoption of standards for mission cost and schedule buffers as standardised by space agencies internationally.

Comment: The SSIF Platform Agreement is a contracting vehicle best suited to devolved funding mechanisms where MBIE has a high-level of trust with the contract holder. In a complex mission, with several external dependencies, a service-level agreement may be more appropriate to clearly articulate deliverables, budget and contract scope.

Comment: SSIF monitoring requires the delivery of two annual reports, a forward-looking plan outlining activities for the coming year, and a backwards looking Progress Report outlining achievements in the previous year. For complex, evolving projects such as this, more frequent monitoring and formal touch points with the contract holder to ensure performance and delivery of aims would be preferred.

Influence and Leverage

The MoU provided MBIE less ability than expected to influence decisions about the mission. MBIE's influence was constrained by how work on the mission was divided across multiple parties as well as contractual limitations. A key takeaway from this experience is the critical importance of the mission director - or an equivalent leadership role - having direct authority over, or formal contractual relationships with, all major suppliers.

This became particularly evident when MLLC suggested Rocket Lab should commit more personnel to the mission to increase mission output, as this view was not shared by Rocket Lab and MBIE's technical advisor who considered that challenges in increasing output related to the satellite itself rather than a shortage of operating personnel.

Comment: MBIE had begun working to establish a direct contractual relationship between MLLC and the University of Auckland, to avoid similar situations once the University took over mission operations. Having planned cost buffers is also important to addressing mission challenges where the responsibility for addressing these may fall on New Zealand.

CONCLUSION

New Zealand's involvement in the MethaneSAT mission represented a bold and strategic investment—one that aligned with national priorities to grow space sector capability and to contribute meaningfully to global climate science. Despite the satellite's premature failure, the mission delivered tangible benefits including the establishment of a New Zealand MOCC infrastructure that can provide ongoing benefit to the space and science sector, strengthened international scientific partnerships, and hands-on experience for researchers and students.

The technical failure, while disappointing, occurred in components outside of New Zealand's control and within the bounds of accepted risk in space missions. Importantly, the sensor - MethaneSAT's most innovative element - performed exceptionally well and delivered meaningful science data which New Zealand researchers are utilising now. The decision to partner internationally helped mitigate financial risk and enabled New Zealand to participate in a sophisticated mission at a fraction of the cost of sovereign development.

However, the mission also highlighted challenges in transparency, governance, and public communication. Redacted OIA responses and limited visibility into operational discussions and challenges undermined public confidence. While these constraints were largely due to commercial sensitivity, protecting information supplied in confidence, and competitive dynamics, future missions should proactively manage expectations and ensure clearer communication about scope and limitations.

Governance structures were sound but under-resourced. The complexity of multi-party arrangements demands intensive monitoring and continuity, especially for high-value investments. Within MBIE, the spread of responsibilities across multiple teams reinforced the need for integrated oversight and sustained institutional memory.

Looking ahead, New Zealand can draw on the MethaneSAT experience to inform future space initiatives. Considerations include strengthening contractual leverage, ensuring direct relationships between key technical partners, and investing more in governance and programme management capacity. While sovereign capability remains a costly proposition, strategic international partnerships—if resourced appropriately—can continue to deliver high-impact outcomes for New Zealand's space and climate ambitions.

APPENDIX ONE: MEMORANDUM OF UNDERSTANDING BETWEEN MLLC AND MBIE

December 2020

Separately attached (24 pages)

APPENDIX TWO: PROJECT IMPLEMENTATION PLAN FOR NEW ZEALAND METHANESAT MISSION

December 2020

Separately attached (24 pages)

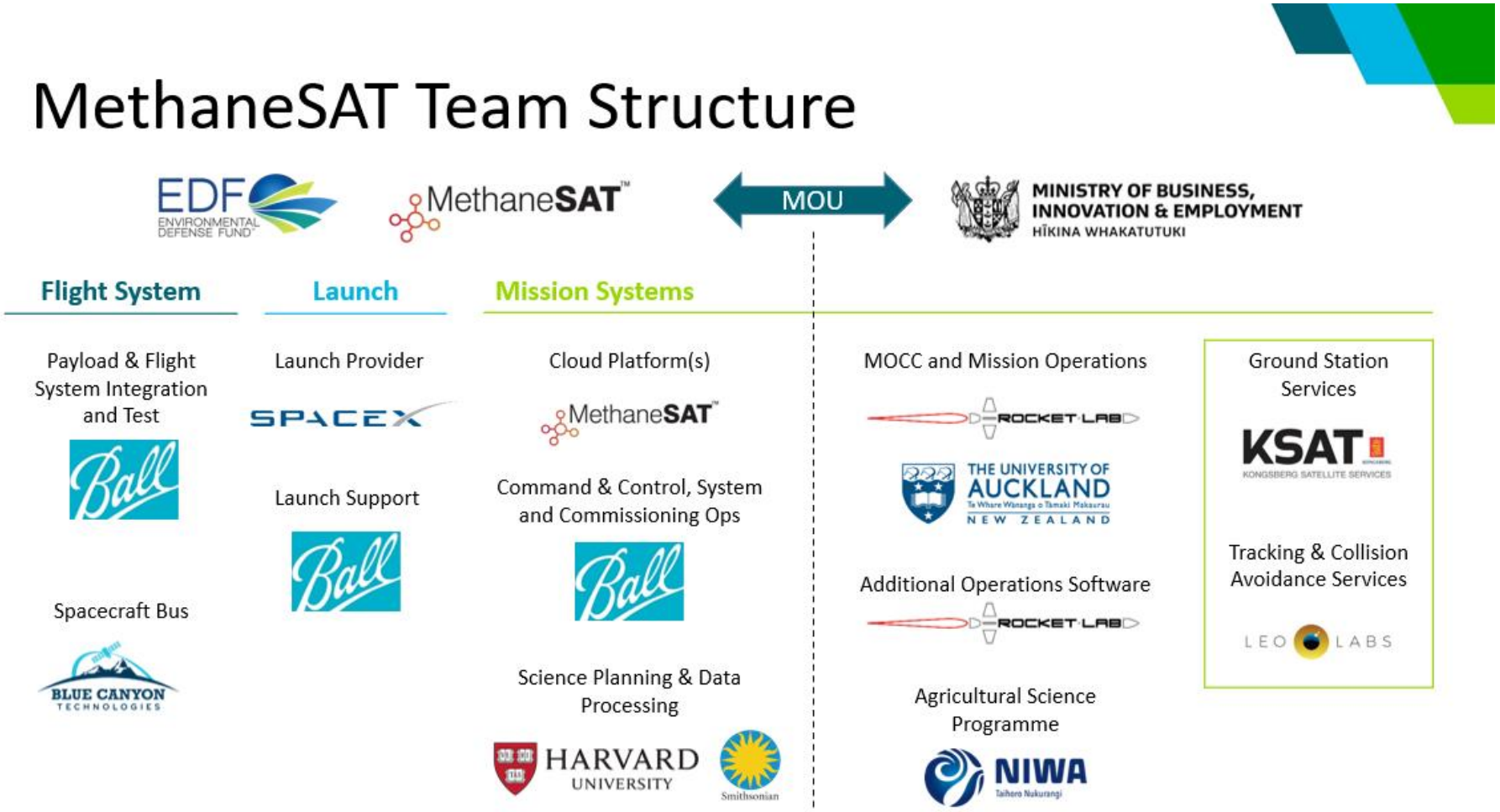
APPENDIX THREE: MULTILATERAL NON-DISCLOSURE AGREEMENT

2020

Separately attached (7 pages)

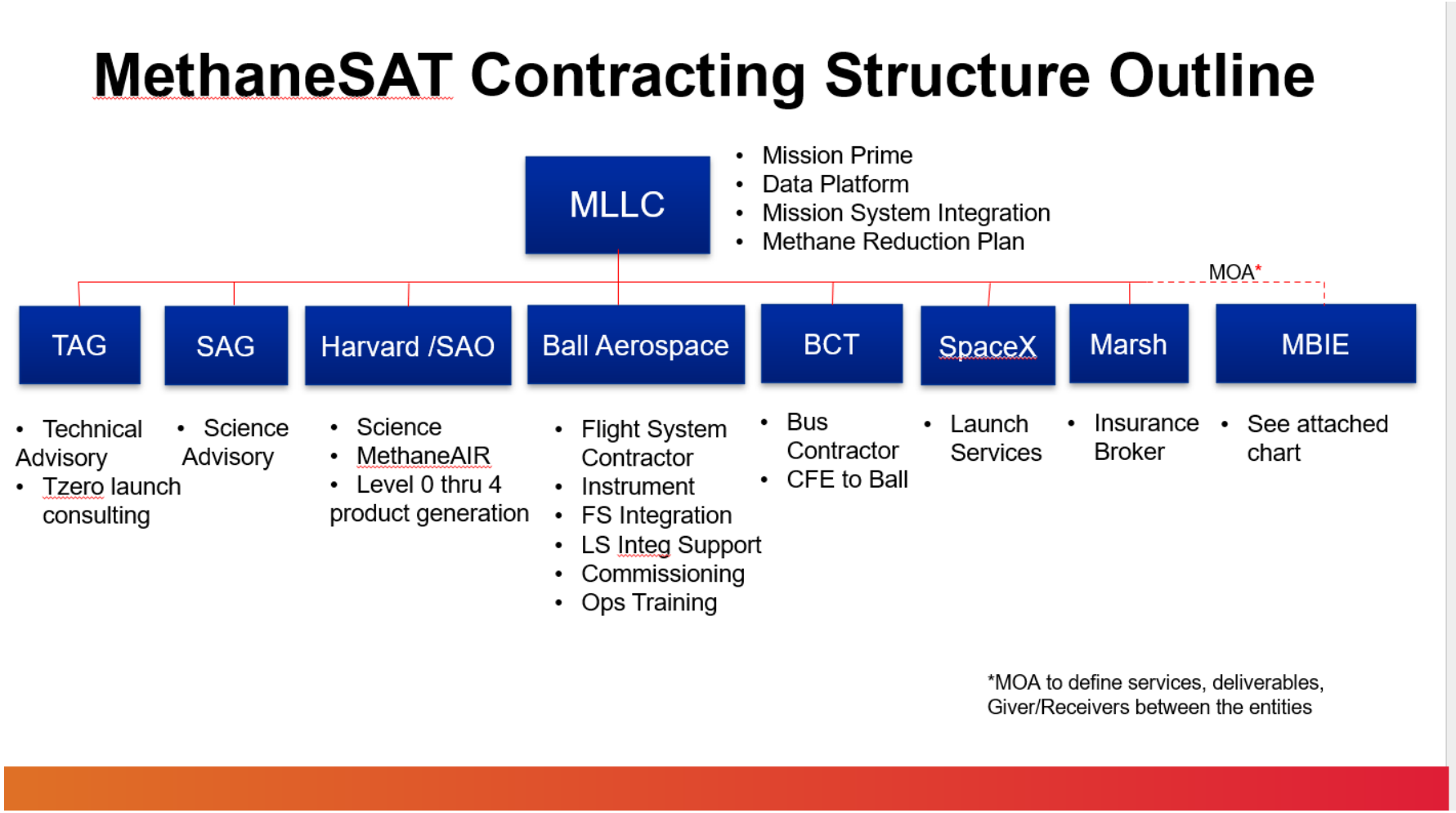
APPENDIX FOUR: METHANESAT PARTNERS AND STRUCTURE

2020



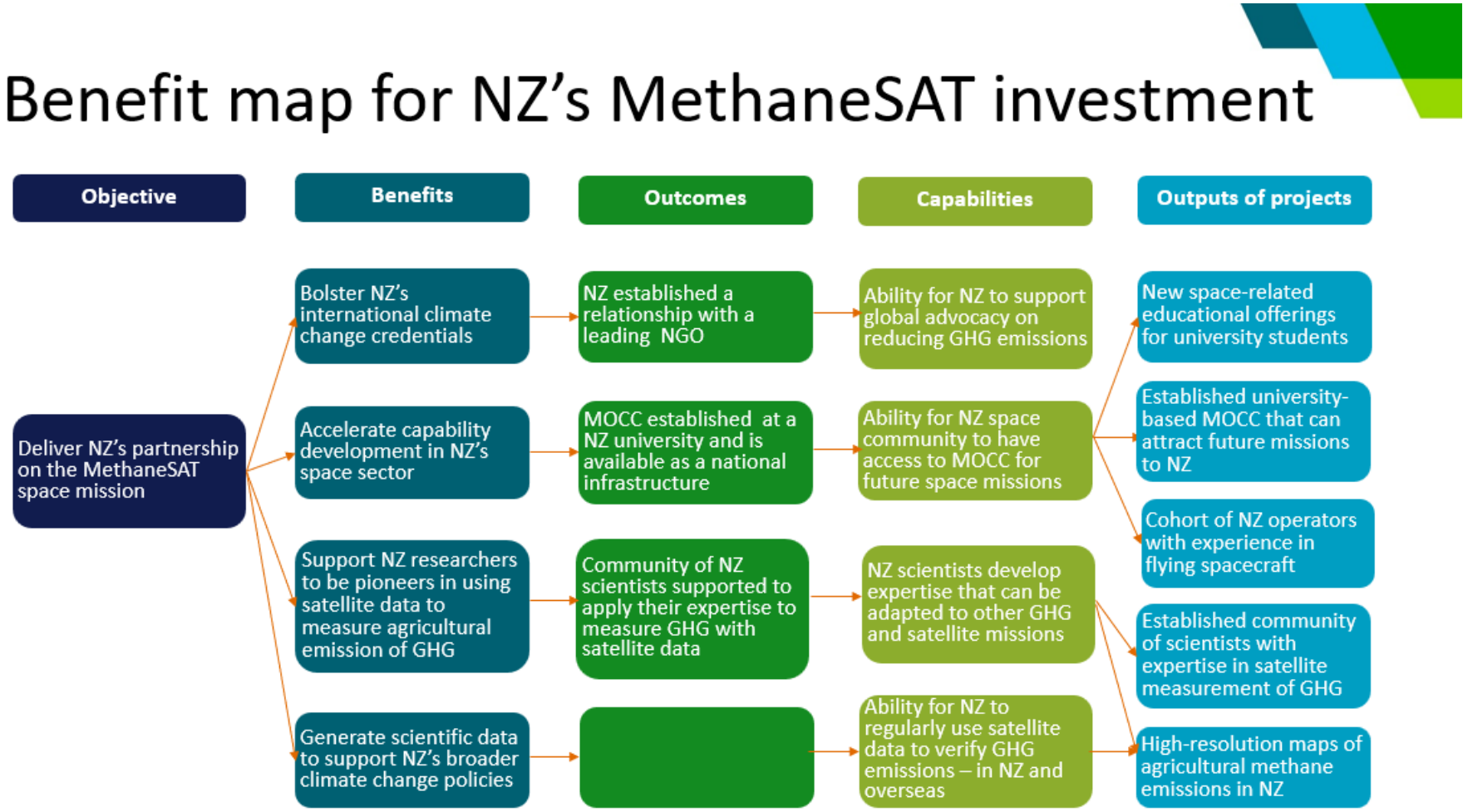
APPENDIX FIVE: METHANESAT CONTRACTING STRUCTURE

2020



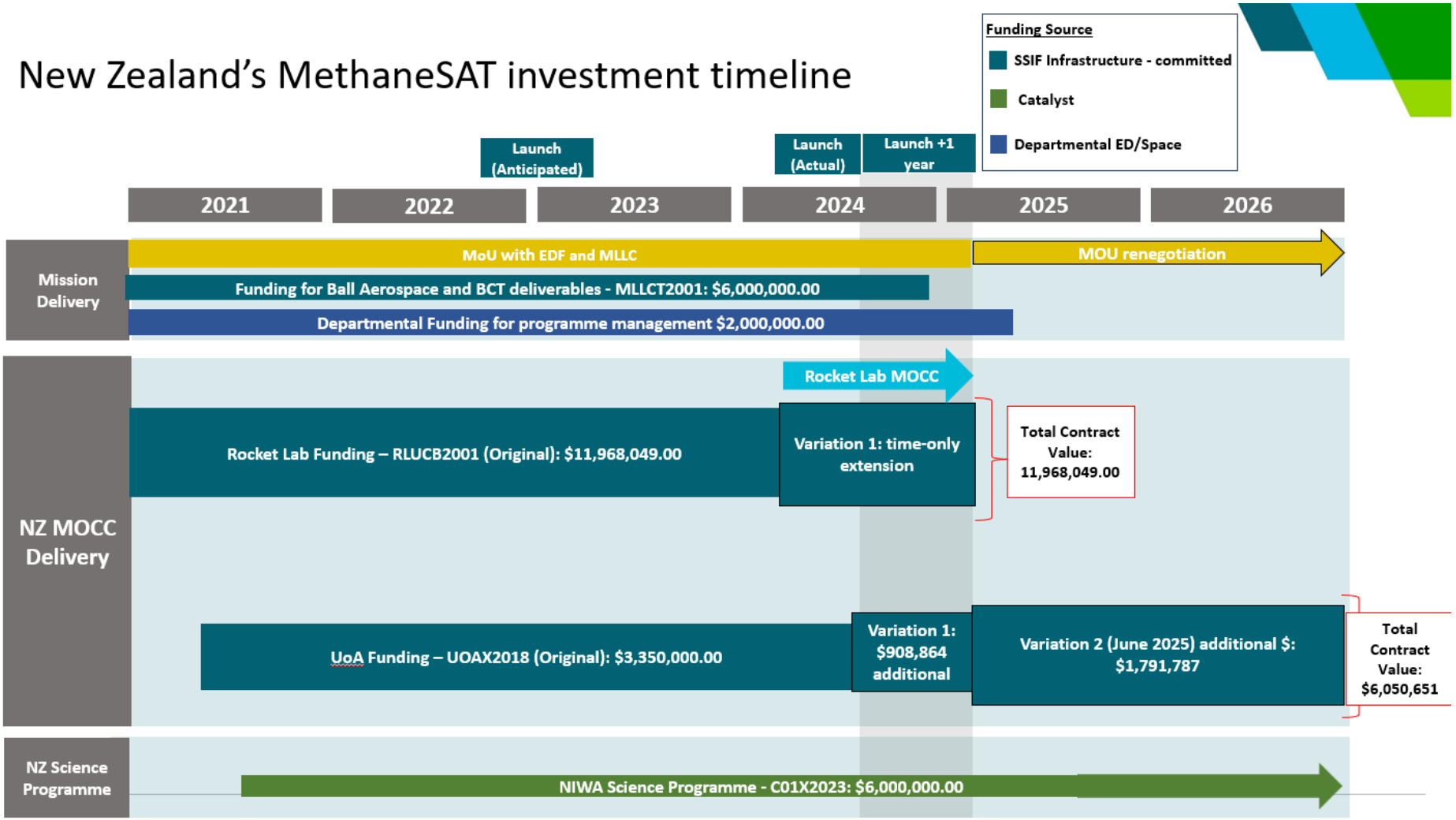
APPENDIX SIX: NEW ZEALAND INVESTMENT LOGIC

2020



APPENDIX SEVEN: MBIE INVESTMENT TIMELINE

2021 – 2025



APPENDIX EIGHT: ADVICE TO MINISTER FOR SPACE

Nov 2023-present

BRIEFINGS

Reference	Key points
February 2024 Briefing to Minister for Space and for Science, Innovation and Technology **Reference: 2324-1619** *"MethaneSAT – Mission Brief"*	This briefing was a high-level overview of the MethaneSAT mission and the New Zealand Government contribution, ahead of the March 2024 launch form California. It summarised (from previous briefings): • New Zealand objectives • Funding committed to date ($30.22 million:

WEEKLY REPORT ITEMS

Date	Short summary
6/3/2024	MethaneSAT launched and entered commissioning phase, with Rocket Lab piloting from MOCC and emissions data expected in three months.
13/3/2024	International media profiled MethaneSAT's capability to monitor global methane emissions.
3/7/2024	Finance Minister declined expense transfer for MSAT, while Rocket Lab and MLLC work to resolve technical issues.
14/8/2024	Rocket Lab continues MSAT operations amid technical fixes, with global anticipation for data and promising early results from MethaneAIR campaign.
10/10/2024	Rocket Lab managing recurring subsystem issues while testing automation to improve MSAT data downlinking.
31/10/2024	Rocket Lab expanded downlink scheduling despite technical challenges, with UoA preparing to assume operations. Data presented at UN climate meeting, COP29.
19/2/2025	MBIE coordinated with partners to transition MethaneSAT operations to BCT, addressing staffing and technical concerns.
19/3/2025	BCT assumed satellite operations, initiated software improvements, and collaborated with UoA and NIWA on data validation.
21/5/2025	MBIE and partners agreed on milestones for UoA to take over MethaneSAT operations, with improved sensor performance and ongoing training.
9/7/2025	Contact with the MethaneSAT satellite was declared lost, ending mission operations and prompting MBIE to pause future MOCC payments.

APPENDIX NINE: ANOMALY INVESTIGATION INTO THE LOSS OF COMMUNICATION WITH METHANESAT

This document sets out the process and findings from an investigation into technical drivers for the mission failure of MethaneSAT.

Separately attached (2 pages)

APPENDIX TEN: TECHNICAL MILESTONES FOR HANDOVER FROM BCT TO NEW ZEALAND

Agreed *May 2025* between MLLC, MBIE and the University of Auckland

Milestone	Activity	Deliverable	Date
1. Thruster Operations Compatible with Science Mission.	Stabilize operational status of MethaneSAT thrusters. **Organizations responsible for delivery: MLLC and BCT**	Summary of operational health for each thruster with demonstrated capability including any necessary software patches to be applied and demonstrated to be effective. Updated ground procedures and demonstrated operation in proposed mission science con-ops configuration. (i.e. if two thrusters are to be utilized simultaneously they should be demonstrated to be capable of this, and the predicted performance should be verified in operation.) Validate thruster operations procedures with any modifications to flight and ground software. Include necessary re-conditioning scripts and procedures for use, if required. **Tasks:** • Uplink flight software patch(es) • Power on and cold test the thrusters • Switch to hot standby/liquid indium • Perform thruster testing • Perform thruster operations (i.e. nominal firing to raise altitude)	31 May 2025 (3 months after transfer to BCT)

Milestone	Activity	Deliverable	Date
2. Development of new science collection con-ops	Devise new mission con-ops (C2 workflow) compatible with the remaining thrusters and their demonstrated performance to support orbit raising and science operations **Organization responsible for delivery: MLLC**	Produce a mission workflow compatible with "safe" science collections and confirm that routine end-to-end science collections are supported with the necessary cadence for orbit maintenance. Document these for independent review with deviations from prior con-ops explicitly noted.	31 May 2025 (3 months after transfer of MOCC)
3. Translation of new con-ops to existing MethaneSAT Mission software, procedures and architecture	Integrate C2 scripts and procedures into existing mission operations architecture and key software/dependencies **Organization responsible for delivery: MLLC, with support from UofA**	Updated ground procedures and scripts to enable operation per the new ConOps. **Tasks:** • Additional onboard automations, including SADA re-initializations and solar array "feathering" while in eclipse • Work with UofA team to provide updated training, procedures and documentation.	15 June 2025 (3.5 months after transfer of MOCC)
4. MethaneSAT is nominally operational	Deliver a nominally operational satellite ready for handover to UofA. **Organization responsible for delivery: MLLC**	Demonstrated end-to-end complete operation of new con-ops for at least 10 days. Target of 20 X-band high data-rate contacts per day during science data collection periods. In this deliverable, a nominally operational satellite is defined by the following:	30 June 2025 (4 months after transfer to BCT) as target, but 31 July 2025 (5

Milestone	Activity	Deliverable	Date

		• Greater than 95% <u>average</u> uptime for spacecraft operations, excluding Single Event Upsets.
		• Downtime metric to be measured as the time periods when the satellite is <u>NOT</u> performing or unable to perform:
		  ○ Science mission data collection
		  ○ Ground station communications
		  ○ Thrusting operations
		  ○ Satellite maintenance activities
		• Demonstrated MTTR of < 4 hours for known issues/anomalies
		
		Support contracts are in place between MLLC and BCT and BAE, with ties to UofA, to provide anomaly resolution support for any unknown anomalies that may arise after handover.
		
		This, alongside milestones 5 and 6 completes prerequisites for transition back to NZ.
			months after transfer to BCT) at the latest

5. UofA Staffing to appropriate level to operate the mission.	Staff hiring by UofA to support a nominally operational satellite (as defined in milestone 4). **Organization responsible for delivery: UofA, with support from MLLC**	UofA hiring of additional personnel to achieve a meantime to restore (MTTR) of <4 hours for known anomalies*. This is expected to require 4 FTE to support MethaneSAT Operations. Direct contract between MLLC and UofA active to support additional staffing needs. Staff are trained and certified for flight operations of MethaneSAT. *note – 'known anomalies' list to be provided by BCT and updated as required up to the point of handover	31 July 2025

Milestone	Activity	Deliverable	Date
6. KSAT contract in place through remainder of mission	UofA has established a contract mechanism with KSAT to provide ground station support. **Organization responsible for delivery: UofA, noting that MBIE intends to contribute some funding towards this contract (as it deemed appropriate), should an appropriate contract be entered into between UofA and KSAT**	A KSAT contract vehicle is in place to provide the minimum required 20 ground station passes per day on the approved MethaneSAT sites. This will replace the current, temporary BCT contract for KSAT services and will come into effect once the MOCC is transferred to the UofA. The contract should be flexible to enable an increase in passes per day as practicable.	30 June 2025
7. Mission operations automation/ OpenC3 migration	Complete, test (including use with the spacecraft) and deliver the Open C3 software. **Organization responsible for delivery: MLLC, with *RL and/or UoA support***	Demonstrate capability in end-to-end demonstration. Provide test procedures and training on newly developed code/capabilities with con-ops to support reduced on-console cadence. Expand ground software automation to reduce operator workload.	Optional for Handover. Target: 31 July 2025 (5 months after transfer to BCT) At the latest: 31 December 2025 (10 months after transfer to BCT)