



INSTRUCTIONS TO BIDDERS

for

**Satellite Systems, Ground Segments and GIS
Applications/Solutions**

**THAILAND EARTH OBSERVATION SYSTEM-2
(THEOS-2)**



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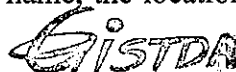
A GENERAL

1. Scope of Bid

- 1.1 GISTDA, Ministry of Science and Technology, Government of Thailand, (hereinafter referred to as the Employer), wishes to receive bids for the development of the THEOS-2 Project. The purpose of the THEOS-2 is to deliver values from space to Thailand beyond what achieved by the THEOS-1. Currently the THEOS-1 consists of a satellite, a number of application systems and a ground receiving station networks. The THEOS-2 is aimed to institute an integrated area-based solution enabler platform by leveraging remote sensing technology, geo-spatial technology and big data analytics to address key priorities of Thailand as mentioned in the 20-year National Strategic Action Plan (2017-2036) and the 12th National Economic and Social Development Plan. The provision of external data, solutions and applications, very high resolution satellite and small satellite systems, IT infrastructure design, capacity building and technology transfer, engineering model together with other works as defined in these Bid documents shall be hereinafter referred to as “the Works”.
- 1.2 The bidder being selected as successful bidder will be expected to complete the Works within 1826 days from the date of commencement of the Works.

2. Eligible Bidders

- 2.1 This Invitation to Bid (ITB) is open to firms, Joint Venture / Consortium / Other Associations that are capable of delivering the Works (the provision of external data, solutions and applications, very high resolution satellite and small satellite systems, IT infrastructure design, capacity building and technology transfer, engineering model together with other works as defined in these Bid documents) pursuant to Clause 1.1, for that the information on relevant experiences, delivered within the past five years, shall be provided. The firms, Joint Venture / Consortium / Other Associations shall provide at least one Certificate of Achievement from Employer(s) for both (1) Satellite System(s) and (2) Application(s). For foreign firms, Joint Venture / Consortium / Other Associations, the corporate document described in paragraph a) through h) below shall be provided. For local firms, Joint Venture / Consortium / Other Associations, the corporate document described in paragraph a) through f) below shall be provided.
- a) A copy of Company Registration Certification (Certified true and correct by authorized person) or the latest Affidavit of Company – Said Affidavit should have the details of the company name, the location of the company, the registered capital, the

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Instructions to Bidders

authorized signatories and company's objective or a copy of the Prospectus of the company (Certified true and correct by authorized person);

- b) The Memorandum of Association;
- c) The Article of Association;
- d) A copy of the list of Director/Managing Director/Stakeholder (Certified true and correct by authorized person);
- e) A certificate of Power of Attorney / Proxy;
- f) A copy of Passport of the Grantor with signature to certify the true copy by the Grantor;
- g) A copy of Passport of the Grantee with signature to certify the true copy by the Grantee;
- h) Paragraph a) through f) above shall be certified by Notary Public and Thai Embassy or Consulate of the bidder's country.

2.2 Bids submitted by a joint venture (JV) of two or more firms as partners, shall comply with the following requirements;

- a) The Bid, and in case of a successful Bid, the Form of Agreement, shall be signed so as to be legally binding on all partners;
- b) One of the partners shall be authorized to be in charge; and this authorization shall be evidenced by submitting a special power of attorney signed by legally authorized signatories of all the partners;
- c) The partner in charge shall be authorized to incur liabilities, receive payments and receive instructions for and on behalf of any or all partners of the JV;
- d) All partners of the JV shall be jointly and severally liable for the execution of the Contract in accordance with the Contract terms to be mutually agreed, and a relevant statement to this effect shall be included in the authorization mentioned under b) above as well as in the Bid Form and the Form of Agreement (in case of a successful Bid); and
- e) A copy of the notarized Joint Venture Agreement to be entered into by the JV partners shall be submitted with the Bid.

2.3 A Bidder shall not have a conflict of interest. All Bidders found to have a conflict of interest shall be disqualified. A Bidder may be considered to have conflicting interests with another Bidder in any of the events described in paragraph a) through c) below and a

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general conflict of interest in any of the circumstances set out in paragraph d) through e) below;

- a) have controlling shareholders in common;
- b) receive or have received any direct or indirect subsidy from any of them;
- c) have the same legal representative for purposes of this Bid;
- d) have a relationship with each other, directly or through common third parties, that puts them in a position to have access to information about or influence on the Bid of another Bidder, or influence the decisions of GISTDA regarding this bidding process;
- e) submit more than one Bid in this bidding process. However, this does not limit the participation of subcontractors in more than one Bid, or as Bidders and subcontractors simultaneously.

2.4 Neither being listed in the List of Work Abandoners officially published by the Government, nor being affected by the result of other person or juristic person being officially declared as Work Abandoner by the Government.

2.5 Not having privilege or immunity of not being subject to the jurisdiction of Thai courts, unless the government of such Bidder has declared that such privilege or immunity is waived.

2.6 Not being a person who fails to submit the Revenue and Expense Accounts or fail to present proper and complete Revenue and Expense Accounts under the Notification of the National Anti-Corruption Commission Concerning Principles and Methods of Preparing Revenue and Expense Accounts of Project between Individual/Company and Government Agencies B.E. 2554 (A.D. 2011), and Amendments.

2.7 Key suppliers in the consortium shall provide previous experience in completing programs similar to the prime contractor proposed in this scope of work for THEOS-2, and in particular shall show how the various elements (upstream, midstream, downstream etc.) have been co-ordinated and managed successfully as an integrated system.

3. Eligibility/Qualification of the Bidder

This Invitation to Bid is open to firms, Joint Venture / Consortium / Other Associations pursuant to Clause 2.1 for the development of the Works pursuant to Clause 1.1 under the THEOS-2 Project only.



4. Cost of Bidding

The bidder shall bear all costs associated with the preparation and submission of his bid and GISTDA will in no case be responsible or liable for those costs.

B BID DOCUMENTS

5. Content of Bid Documents

5.1 The bid documents are those stated below, and should be read in conjunction with any Addenda issued in accordance with Clause 7:

Volume No. 1: Instructions to Bidders

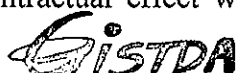
- Annex 1-4
- Appendix 1-11

5.2 The bidder is expected to examine carefully the contents of the Bid documents. Failure to comply with the requirements of bid submission will be at the bidder's own risk. Bids which are not substantially responsive to the requirements of the Bid documents will be rejected.

5.3 These Bid Documents above are for the purpose of guidance only. Subject only to paragraphs (1) and (2) below, such documents and any other document containing information and any minutes of discussions in relation to any aspect of the Bid of the project shall not form any part of any contract subsequently to be concluded between GISTDA and the Bidder, nor be used in interpreting or construing any such contract, and neither GISTDA nor its agents shall be responsible in any manner whatsoever for any representation of information contained therein.

(1) Except for any such written clarification by the Executive Director of GISTDA which is expressly stated to be by way of an addendum to the documents referred to in paragraph 5.1 above and for any other document issued by GISTDA which is similarly described, no written or verbal communication, representation or explanation by any employee of GISTDA or its agents shall be binding on GISTDA or agents thereof or shall be taken to bind or fetter GISTDA under the Contract.

(2) The Bidder should note that there may be aspects of his Bid and/or the documents submitted with the Bid which will necessitate discussion and clarification. It is intended that any aspect of the said documents and any amendments or clarifications which are to have contractual effect will be incorporated into the Contract by the

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Instructions to Bidders

Bidder submitting, at the written request of GISTDA, documents which are expressly stated to form part of the Bid, whether requested before or after submission of the documents forming part of the Bid, identified in the Form of Bid and Appendixes to the Form of Bid, and whether as supplements to or amended versions of such documents.

6. Clarification of Bid Documents and Site Visit

- 6.1 Bidders may request for clarification(s) on any part of the Bid Documents or for an interpretation by notifying GISTDA in writing or by fax (hereinafter, the term “fax” is deemed to include all electronic transmission) submitted to GISTDA at GISTDA’s address indicated in the Invitation to Bid. GISTDA will announce of site visit date and place and will respond to any request for clarification on the site visit day which it receives questions earlier than 28 days prior to the deadline for submission of bids by issuing a Supplemental/Bid addendums. All clarifications are to be made available to all those who have properly secured the Bid Documents from GISTDA, at least seven (7) calendar days before the deadline for the submission and receipt of Bids. Copies of GISTDA’s response will be forwarded to all bidders, including a description of the inquiry. The clarification may be made on the occasion of re-meeting and site visit as defined in Clause 14.
- 6.2 It shall be the responsibility of all those who have properly secured the Bid documents to inquire and secure Supplemental/Bid addendums that may be issued by GISTDA.

7. Amendment of Bid Documents

- 7.1 Not later than seven (7) calendar days prior to the deadline for submission of bids, Supplemental/Bid addendums may be issued upon, whether at the GISTDA’s initiative or in response to a clarification requested by a bidder for purposes of clarifying or modifying any provision of the Bid Documents.
- 7.2 Any addendum thus issued shall be part of the Bid Documents pursuant to Sub-Clause 5.1. It is the responsibility of GISTDA to notify in writing or by fax to all those who have properly secured the Bid documents. Bidders shall acknowledge receipt of each addendum by fax to GISTDA.
- 7.3 Any modification of the Bid Documents shall be identified as an amendment. Bidders who have submitted Bids before the issuance of the Supplemental/Bid addendums must be informed and allowed to modify or withdraw their Bids.



C PREPARATION OF BIDS

8. Language of Bid

The Bid prepared by the Bidder, as well as all correspondence and documents relating to the Bid exchanged by the Bidder and GISTDA, shall be written in English. Supporting documents and printed literature furnished by the Bidder may be in another language provided they are accompanied by an accurate translation of the relevant passages in English, in which case, for purposes of interpretation of the Bid, the English translation shall govern.

9. Documents Comprising the Bid

9.1 The bid submitted by the bidder shall comprise the following:

- (1) "Technical Proposals" and
- (2) "Pricing Documents"

The bidder shall, on or before the date given in the Letter of Invitation to Bid, deposit its Bid package in two sealed envelopes clearly marked;

"THEOS-2, Bid Volume 1: "Technical Proposals", and

"THEOS-2, Bid Volume 2: "Pricing Documents".

These shall be addressed to The Executive Director of GISTDA and submitted to the Bid Room on the sixth floor at the office of GISTDA on 120 The Government Complex Commemorating His Majesty The King's 80th Birthday Anniversary, 5th December, B.E. 2550 (2007) Ratthaprasasanabhakti Building 6th and 7th Floor, Chaeng Wattana Road, Lak Si Bangkok 10210, Thailand from 0830 to 1630. The bidder shall ensure that a receipt is obtained for each of the submissions, such receipt being issued free of charge by GISTDA.

Bids submitted after the period stated above will be rejected, withdrawal of Bids after Bid Submission shall not be allowed.

Volume 1 "Technical Proposals"

(1) This submittal/submission shall contain these documents;

Form of Bid (Annex 1A), and Bid Securities (Annex 1B)

Form of Agreement

Form of Securities



Instructions to Bidders

Prelude to Insight of Bid Requirement Context (Instructions to Bidders)

Solutions and Applications

Provision of External Data

Very High Resolution Satellite and Small Satellite Systems

IT Infrastructure Design

Capacity Building, Technology Transfer Satellite Engineering Model

Bid Program

Business Development

Reference Information

And all other documents described in the Bid Documents but shall not contain any bid price information.

- (2) The Bidder shall also submit with its Bid the following documents;
- a) Full details of ownership and control of the Bidder
 - b) Details of sub-contracts and specialist work
 - c) Information on relevant experiences, delivered within the past five years and at least one Certificate of Achievement from Employer(s) for both (1) Satellite System(s) and (2) Application(s).
 - d) Any further document which are requested in writing by GISTDA as part of the submission of the Bid, by way of Qualification and evaluation documents, but which are not to form part of the Contract.

Such documents will be used for the purposes of evaluating and analyzing the Bid but will not form part of the Contract unless the same shall have been identified to.

Volume 2 “Pricing Documents”

This submittal/submission shall contain the

- (1) The Form of Bid
- (2) Appendices to the Form of Bid
- (3) The completed Annex 4 Pricing Document



Instructions to Bidders

(4) Any other document described in the Bid documents

- 9.2 The Form of Bid, Appendix to Bid, Bid Security and Bill of Quantities shall be filled-in without exception, subject to extensions thereof in the same format and to the provisions of Sub-Clause 13.2 regarding the alternative forms of bid security.
- 9.3 The Form of Bid shall be fully completed and shall be signed by a duly authorized and empowered representative of the bidder. In the bidder comprises a partnership, a joint venture / Consortium / Other Association, the Form of Bid shall be signed by a duly authorized representative of each member or participant thereof. Signatures on the Form of Bid shall be witnessed and dated. Copies of relevant powers of attorney should be attached.

The bidder shall submit the original together with six (6) copies of each of the documents specified in Sub-Clause 9.1 herein.

10. Bid Prices

- 10.1 Unless stated otherwise in the Bid documents, the Contract shall be for the whole Works as described in Sub-Clause 1.1, based on the priced Bill of Quantities submitted by the bidder.
- 10.2 In this regard, where a required item is provided, but no rate or price is entered by the bidder, the same shall be considered "0" (zero) for the said item would mean that it is being offered for free to the Government i.e. bidder will not be paid for by GISTDA when executed and shall be deemed covered by the other rates and prices in the Bill of Quantities.
- 10.3 The bidder shall fill in prices for all items of the Works described in the Bill of Quantities. Bids not addressing or providing all of the required items in the Bid documents including, where applicable, bill of quantities, shall be considered non-responsive and, thus, automatically disqualified.
- 10.4 All taxes and other levies, excluding custom duty and VAT, payable by the Contractor under the Contract, or for any other cause, as of the date 28 days prior to the deadline for submission of bids, shall be included in the rates, prices and total bid price submitted by the bidder. The bidder shall obtain all the information regarding tax and duties, be familiar with the tax laws of the Government of Thailand and confirm the requirements thereof on its own responsibility.

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11. Currencies of Bid and Payment

- 11.1 The unit rates and the prices shall be quoted by the bidder separately in Thai Baht only.
- 11.2 Payment of the contract price shall be made in Thai Baht only.
- 11.3 The rates of exchange to be used by the bidder for currency conversion during bid preparation shall be the selling rates for similar transactions prevailing on the date 28 days prior to the date of bid opening, as published by National Bank of Thailand. If exchange rates are not so published for certain currencies, the bidder shall state the rates used and the source.
- 11.4 Bidders may be required by GISTDA to clarify their foreign currency requirements, and to substantiate that the amounts included in the unit rates and prices and shown in the Appendix to Bid are reasonable and responsive to Sub-Clause 11.1, in which case a detailed breakdown of its foreign currency requirements shall be provided by the bidder.
- 11.5 Bidder should note that during the progress of the Works, the foreign currency requirements of the outstanding balance of the Contract Price may be adjusted by agreement between GISTDA and the Contractor in order to reflect any changes in foreign currency requirements for the Contract. Any such adjustment shall be effected by comparing the amounts quoted in the bid with the amount already used in the Works and the Contractor's future needs for imported items.
- 11.6 Any payment in the Procurement Contract between the Contractor and GISTDA shall be made via wire transfer.

12. Bid Validity

- 12.1 Bid shall remain valid for a period of 270 days after the date of bid opening specified in Clause 20.
- 12.2 In exceptional circumstances, prior to expiry of the original bid validity period, GISTDA may request that the bidders extend the period of validity for a specified additional period. The request and the responses thereto shall be made in writing or by fax. A bidder may refuse without forfeiting its bid security. A bidder agreeing to the request will not be required or permitted to modify its bid, but will be required to extend the validity of its bid security for the period of the extension, and in compliance with Clause 13 in all respects.



13. Bid Security

13.1 The bidder shall furnish, as part of its bid, a bid security in the amount of five (5) percent of the Contract price in Baht or an equivalent amount in a freely convertible currency.

13.2 The bid security shall, at the bidder's option, be in one of the following form:

- (1) Certified cheque; or
- (2) Cashier's Cheque payable to GISTDA; or
- (3) An Irrevocable letter of credit or bank guarantees issued by a bank which is registered and authorized to do business in Thailand or a foreign bank through a correspondent bank in Thailand and in the format included in ANNEX 1B; or
- (4) An Irrevocable letter of credit or bank guarantees issued by a finance company that has been granted a license to carry out commercial investment and guarantee business as announced by the Bank in Thailand in the format included in ANNEX 1B; or
- (5) Thai Government Bond;
- (6) Bank Draft; or
- (7) Other formats may be permitted, subject to the prior approval of GISTDA.

Letter of credit and bank guarantees issued as surety for the bid shall be valid of 28 days beyond the validity of the bid.

13.3 Any bid not accompanied by an acceptable bid security shall be rejected by GISTDA as non-responsive.

13.4 The bid securities of unsuccessful bidders will be returned as promptly as possible, but not later than 28 days after the expiration of the period of bid validity.

13.5 The bid security of the successful bidder will be returned upon the execution of the Contract Agreement and the receipt by GISTDA of the required performance security.

13.6 The bid security may be forfeited

- (1) if the bidder withdraws its bid during the period of bid validity; or
- (2) if the bidder does not accept the correction of its bid price, pursuant to Sub-Clause 24.2; or
- (3) in the case of a successful bidder, if it fails within the specified time limit to...
 - a) sign the Agreement, or

The logo for GISTDA (Government Information Systems and Technology Development Agency) is displayed. It features the word "GISTDA" in a stylized, bold, sans-serif font. The "G" is particularly large and has a unique shape, with the letters "I", "S", "T", "D", and "A" following in a similar bold style. The logo is black and white.

Instructions to Bidders

- b) furnish the required performance security, or
- c) enter into a JV agreement if it has undertaken to do so.

(4) any other reasons stated in the bid documents.

13.7 In any case, the bid security shall be returned without any interest.

14. Pre-Bid Meeting, Site Visit and Clarification

14.1 The bidder or its official representative is invited by GISTDA to attend a pre-bid meeting which will take place at

Space Krenovation Park

Geo-Informatics & Space Technology Development Agency (Public Organization)
88 Moo 9 Tambon Thung Sukala, Amphoe Siracha, Chonburi

At 1000 hours on 20170216

14.2 The pre-bid meeting shall discuss among other things, the technical and financial components of the contract to be Bid, explain the project, clarify issues and to answer questions on any matter that may be raised at that stage.

14.3 The bidder is requested to submit any questions in writing or by fax, to reach GISTDA not later than seven (7) days before the meeting.

14.4 The minutes of the pre-bid meeting, including the text of the questions raised and the responses given, shall be recorded and made available to all participants and all bidders, not later than three (3) calendar days after the pre-bid meeting. Any modification of the bid documents shall be made by GISTDA exclusively through the issue of an Addendum pursuant to Clause 7 and not through the minutes of the pre-bid meeting.

14.5 Bidders are advised to attend the pre-bid meeting. However, the attendance of the bidders is not mandatory. Hence, nonattendance at this meeting will not be a ground for disqualification of a bidder. Bidders who do not attend the pre-bid meeting assume the responsibility to comply with modifications to the bid documents mentioned in Sub-Clause 14.4 above and which are communicated through an Addendum pursuant to Clause 7.

14.6 GISTDA may organize a site visit concurrent with the pre-bid meeting.

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15. Format and Signing the Bid

- 15.1 The bidder shall submit one original and six (6) copies of the bid documents comprising the bid as described in Clause 9 of these THEOS-2 Terms of Reference (Instructions to Bidders), bound with the volume containing the Form of Bid, and clearly marked “ORIGINAL” and “COPY” as appropriate. In the event of any discrepancy between the “ORIGINAL” and “COPY”, the “ORIGINAL” shall prevail.
- 15.2 The original and all copies of the bid shall be typed or written in indelible ink (in the case of copies, photostats are also acceptable) and shall be signed by a person or persons duly authorized to sign on behalf of the bidder, pursuant Clause 9. All pages of the bid where entries or amendments have been made shall be initialed by the person or persons signing the bid and stamped.
- 15.3 The bid shall contain no interlineations, erasures, alterations, overwriting. Omissions or additions, except those to comply with instructions issued by GISTDA, or as necessary to correct errors made by the bidder, in which case such corrections shall be valid only if they are signed or initialed by the person or persons signing the bid and stamped.

D SUBMISSION OF BIDS

16. Sealing and Marking of Bids

- 16.1 The bidder shall enclose the original of the Technical Proposal in one sealed envelope marked as “ORIGINAL – TECHNICAL PROPOSAL; whereas, the original of the Pricing Document shall be enclosed in another sealed envelope marked as “ORIGINAL – PRICING DOCUMENT.” Both envelopes shall then be placed in another single envelope marked as “ORIGINAL BID”.
- 16.2 Each copy of the Technical Proposal and Pricing Document, shall be similarly sealed duly marked as “COPY NO. ____ – TECHNICAL PROPOSAL” and “COPY NO. ____ – PRICING DOCUMENT” respectively and the outer envelope as “COPY NO. ____”. These envelopes containing the original and the copies shall then be enclosed in one single envelope.
- 16.3 The inner and outer envelopes shall
- (1) Be addressed to GISTDA at the following address:

Geo-informatics and Space Technology Development Agency (Public Organization)

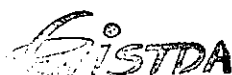
The logo for GISTDA (Geo-Informatics and Space Technology Development Agency) is displayed. It features the word "GISTDA" in a stylized, bold, sans-serif font. The letter "G" is particularly large and has a unique, flowing design. The letters are black with a slight shadow or outline effect.

Instructions to Bidders

120 The Government Complex Commemorating His Majesty The King's 80th Birthday Anniversary, 5th December, B.E. 2550 (2007) Ratthaprasasanabhakti Building 6th and 7th Floor, Chaeng Wattana Road, Lak Si Bangkok 10210, Thailand

and

- (2) Bear the following identification:
 - Bid for THEOS-2
 - DO NOT OPEN BEFORE 20170317 0830 hrs (time and date for bid opening)
 - (3) Submission of the Bid must accompanied by the Bid Security, which shall be brought in a separate envelope by the Bidder. The envelope shall be labeled "THEOS-2 Bid Security".
 - (4) And shall be submitted by hand to GISTDA office. The Bidders shall ensure that official receipt is obtained for the substation, such receipt being issued by GISTDA free of charge.
 - (5) In the case the bidders assign other person to submit the Bids, such person shall be authorized by the Bidders, together with Power of Attorney duly stamped and copy of the certified ID card of assignor and assignee.
- 16.4 In addition to the identification required in Sub-Clause 16.2, the inner envelope shall indicate the name and address of the bidder to enable the bid to be returned unopened in case it is declared as "late" pursuant to Clause 18.
- 16.5 If all envelopes are not sealed and marked as required, GISTDA will assume no responsibility for the misplacement or premature opening of the Bid.
- 16.6 Should any further documents be required the Bidder will be instructed by GISTDA which volume of the Bidder's submission is to contain such documents.
- 16.7 Bidder must submit a conforming Bid. Bids that include:
- (1) Seek to transfer to GISTDA, another Government Agency or another contractor all or part of the risk allocated to be the Contractor in the Bid Documents; or
 - (2) Include a deviation from the Bid Documents which would render the Works, or any part thereof, unfit for their intended purpose; or
 - (3) Fail to price any part of the Works, the costs of which is to be added in the Lump Sum Bid Price after opening of the Pricing Documents; or

The logo for GISTDA (Government Information Systems Technology Development Agency) is displayed. It features the word "GISTDA" in a stylized, bold, sans-serif font. The letter "G" is particularly large and has a unique, rounded shape. The letters "I", "S", "T", "D", and "A" are smaller and more standard in shape. The logo is rendered in a dark, possibly black or dark blue, color.

Instructions to Bidders

- (4) Fail to commit to the date specified for the completion of the Works; shall be deemed non conforming and will be rejected.

16.8 GISTDA is not bound to accept the lowest or any bid and may at any time by notice in writing to the Bidder terminate the bidding process.

17. Deadline for Submission of Bids

17.1 Bids must be received by GISTDA at the address specified above no later than 1630 hours on 20170316. The time aforesaid shall be based on the clock time of GISTDA Bid Room.

17.2 GISTDA may, at its discretion, extend the deadline for submission of bids by issuing an addendum in accordance with Clause 7, in which case all right and obligations of GISTDA and the bidders previously subject to the original deadline will thereafter be subject to the deadline as extended.

18. Late Bid

Any bid received by GISTDA after the deadline for submission of bids prescribed in Clause 17 will be declared “late” and will be rejected and returned unopened to the bidder.

19. Modification and Withdrawal of Bids

19.1 The bidder may modify or withdraw its bid after bid submission, provided that written notice of the modification or withdrawal is received by GISTDA prior to the deadline for submission and receipt of Bids, provided that the corresponding letter of withdrawal contains a valid justification requesting for such withdrawal.

19.2 The bidder’s modification or withdrawal notice / letter of withdrawal shall be prepared, sealed, marked and delivered in accordance with the provisions of Clause 16 with the outer and inner envelopes additionally marked “MODIFICATION” or “WITHDRAWAL”, as appropriate. A withdrawal notice may also be sent by fax but must be followed by a signed confirmation.

19.3 No bid may be modified by the bidder after the deadline for submission of bids.

19.4 Withdrawal of a bid during the interval between the deadline for submission of bids and the expiration of the period of bid validity specified in the Form of Bid may result in the forfeiture of the bid security pursuant to Clause 13.



E BID OPENING AND EVALUATION

20. Bid Opening

- 20.1 GISTDA will open the bid envelopes, including modifications made pursuant to Clause 19, in the presence of bidders' representatives who choose to attend, at 0830 hours on 20170317. The time aforesaid shall be based on the clock time of GISTDA Bid Room at the following location:

Geo-informatics and Space Technology Development Agency (Public Organization)

120 The Government Complex Commemorating His Majesty The King's 80th Birthday Anniversary, 5th December, B.E. 2550 (2007) Ratthaprasasanabhakti Building 6th and 7th Floor, Chaeng Wattana Road, Lak Si Bangkok 10210, Thailand

The bidders' representatives who are present shall sign a register evidencing their attendance.

- 20.2 Envelopes marked "WITHDRAWAL" shall be opened first and the names of the bidders and Letters of Withdrawal shall be read out and recorded. The envelope containing the corresponding withdrawn Bids for which an acceptable notice of withdrawal has been submitted pursuant to Clause 19 shall be returned to the Bidder unopened. If the withdrawing Bidder's representative is in attendance the original Bid and all copies thereof shall be returned to the representative during the Bid opening. If the representative is not in attendance, the Bid shall be returned unopened by registered mail.
- 20.3 The bidders' names, the presence or absent of bid security and such other details as GISTDA may consider appropriate, will be announced and recorded by GISTDA at the opening. The bidders' representatives will be required to sign the record.
- 20.4 GISTDA will prepare minutes of the bid opening, including the information disclosed to those present.
- 20.5 Prior to the detailed evaluation of bids, GISTDA will determine the responsiveness of bids.
- 20.6 A substantially responsive bid is one which confirms to all the terms, conditions and specifications of the Bid Documents, without material deviation or reservation. A material deviation or reservation is one
- (1) which affects in any substantial way the scope, quality or performance of the Works;

The logo for GISTDA (Geo-Informatics and Space Technology Development Agency) is displayed in a stylized, handwritten font.

Instructions to Bidders

- (2) which limits in any substantial way, inconsistent with the Bid Documents, GISTDA's rights or the bidder's obligations under the Contract; or
- (3) whose rectification would affect unfairly the competitive position of other bidders presenting substantially responsive bids.

20.7 If a bid is not substantially responsive, it will be rejected by GISTDA.

20.8 The Bidder who is rejected by the caused stated above may appeal to the Executive Director of GISTDA within fifteen (15) days after receipt of the notice of disqualification. The consideration and decision by the Board of Directors of GISTDA shall be final.

20.9 The appeal in the preceding paragraph will not be the cause to delay except that the Executive Director of GISTDA may consider that such delay will be of an advantage to GISTDA. In the event that the Executive Director of GISTDA agrees with the appeal and cancellation of the bid is deemed advantageous to GISTDA, the Executive Director is authorized to undertake such cancellation.

20.10 GISTDA shall then open the envelopes holding the Technical Proposals one at a time, and read out and record the following:

- (1) the name of the Bidder;
- (2) the presence, amount and validity of the Bid Security;
- (3) the presence or absence of each document comprising the technical proposal vis-à-vis a checklist of the required document.

20.11 GISTDA shall determine each Bidder's compliance with the documents required to be submitted for the Technical Proposal of the Bid. For this purpose, GISTDA shall check the submitted documents of each Bidders' against a checklist of required documents to ascertain if they are all present in the first (technical) envelope, using a non-discretionary "pass/fail" criteria. If a Bidder submits all required document, it shall be rated "passed" for that particular requirement. In this regard, failure to submit a requirement, or an incomplete or patently insufficient submission, shall be considered "failed" for the particular requirement concerned. In case one or more of the above required documents in the first envelope of a particular Bid is missing, incomplete, or patently insufficient, GISTDA shall rate the Bid concerned as "failed" and immediately return to the Bidder concerned its second (Pricing) Bid enveloped unopened.

The logo for GISTDA, featuring the word "GISTDA" in a stylized, handwritten-style font. The "G" is large and loops around the "I", and the "S" is also stylized.

Instructions to Bidders

- 20.12 The Technical Proposal of the Bidders who satisfy the Sub-Clause 20.5 will be evaluated on a 100 percentage scoring system, using pre-determined evaluation criteria.
- 20.13 After that GISTDA shall forthwith open the envelopes holding the Pricing Documents of each remaining eligible bidder whose Technical Proposals was rated “passed” (Technical Proposal score 80% or above) in the public. The envelopes holding the Pricing Documents of the bidders whose Technical Proposal score less than 80% will be returned to Bidders unopened.
- 20.14 In case one or more of the requirements in the Pricing envelope of a particular bid is missing, incomplete or patently insufficient, and/or if the submitted total bid price exceeds the approved budget for the contract, GISTDA shall rate the bid concerned as “failed.” Bids that are determined to contain all the requirements for the Pricing envelope shall be rated “passed” and shall immediately be considered for detailed evaluation of the Bid.
- 20.15 GISTDA shall prepare the minutes of the proceedings of the Bid opening that shall include, as a minimum:
- (1) abstract of Bids as read including names of Bidders, their Bid price, Bid Security of preliminary examination; and
 - (2) attendance sheet. GISTDA members shall sign the abstract of Bids as read and the observers may witness the same.

A copy of the abstract of Bids as read shall be made available to all interested Bidders. The minutes of the proceedings of the Bid opening shall be available to the public upon written request.

21. Process to be Confidential

Information relating to the examination, clarification, evaluation and comparison of bids and recommendations for the award of a contract shall not be disclosed to bidders or any other persons not officially concerned with such process until the award to the successful bidder has been announced. Any effort by a bidder to influence GISTDA’s processing of bids or award decisions may result in the rejection of the bidder’s bid.

22. Clarification of Bids from Bidder(s)

- 22.1 To assist in the examination, evaluation and comparison of bids, GISTDA may, at its discretion, ask any bidder for clarification of its bid, including breakdowns of unit rates.

The logo for GISTDA, featuring the word "GISTDA" in a stylized, handwritten-style font. The letters are dark and have a slightly textured appearance.

Instructions to Bidders

The request of clarification and the response shall be in writing or by fax, but no change in the price or substance of the bid shall be sought, offered or permitted except as required to confirm the correction of arithmetic errors discovered by GISTDA in the evaluation of the bids in accordance with Clause 24.

- 22.2 Before awarding or executing the contract, GISTDA shall have the right to ascertain the facts or status, position or other evidence concerning the successful Bidder. GISTDA shall also have the right not to award or execute the contract if such evidence proved the Bid to be unreasonable and improper.

23. Preliminary Examination of Bid

- 23.1 Prior to the detailed evaluation of bids, GISTDA will review whether each bid
- i) Has been properly signed;
 - ii) is accompanied by the Determination of required securities;
 - iii) any possibility of joint benefit or obstruction of fair and competitive bid.
- 23.2 Prior to or during the bid review stated above, should it become evident that any Bidder has joint benefit with the others or has committed any act to obstruct fair and competitive bid proceeding, such Bidder shall be disqualified and shall be rejected by GISTDA.
- 23.3 The bidder who is disqualified by the cause stated above may appeal to the Executive Director of GISTDA within 3 days after receipt of the notice of disqualification. The consideration and decision by the Executive Director of GISTDA shall be final.
- 23.4 The appeal in the preceding paragraph will not be the cause to delay the opening and review of the Technical Proposal and the Pricing Documents, except that the Executive Director of GISTDA may consider that such delay will be of an advantage to GISTDA. In the event that the Executive Director of GISTDA agrees with the appeal and cancellation of the bid is deemed advantageous to GISTDA, Executive Director of GISTDA is authorized to undertake such cancellation.

24. Correction of Errors

- 24.1 Bids determined to be substantially responsive will be checked by GISTDA for any arithmetic errors. Arithmetic errors will be rectified on the following basis. If there is a discrepancy between the unit rate and the total cost per item that is obtained by multiplying the unit rate and quantity, the unit rate shall prevail and the total cost per item will be corrected unless in the opinion of GISTDA there is an obvious misplacement of the decimal point in the unit rate, in which case the total cost per item as quoted will

The logo for GISTDA, featuring the word "GISTDA" in a stylized, handwritten-style font.

Instructions to Bidders

govern and the unit rate corrected. If there is a discrepancy between the total bid amount and the sum of the total costs per item, the sum of the total costs per item shall prevail and the total bid amount will be corrected.

- 24.2 The amount stated in the Form of Bid will be adjusted by GISTDA in accordance with the above procedure for the correction of errors and, shall be considered as binding upon the bidder. If the bidder does not accept the corrected amount of bid, its bid will be rejected, and the bid security may be forfeited in accordance with Sub-Clause 13.6 (2).

25. Detailed Evaluation and Comparison of Bids

- 25.1 GISTDA will evaluate and compare only the bids qualified as in accordance with Clause 3, 20.5, 20.6, and 23.

25.2 The evaluation of bidder's Technical Proposal

The evaluation of bidder's Technical Proposal shall be by using pre-determined evaluation criteria as in Appendix 10.

- 25.3 In evaluating the Pricing Document of Bidders whose Technical Proposals were rated "passed" (Technical Proposal score 80% or above), GISTDA shall take into account the price and other commercial feature of the offer and determine for each bid the Evaluated Bid Price by adjust the Bid Price as follow:

- (1) making any correction for errors pursuant to Clause 24;
- (2) excluding Provisional Sumas and the provision, if any, for Contingencies in the Summary Bill of Quantities, but including Daywork.

- 25.4 GISTDA reserves the right to accept or reject any variation, deviation or alternative offer. Variations, deviations, alternative offers and other factors which are in excess of the requirements of the Bid document or otherwise result in the accrual of unsolicited benefits to GISTDA shall not be taken into account in bid evaluation.

- 25.5 The estimated effect of the price adjustment provisions of the Conditions of Contract, applied over the period of execution of the Contract, shall not be taken into account in bid evaluation.

- 25.6 GISTDA will open the Pricing Documents of bidders rated "passed" pursuant to Clause 25.3 above and will evaluate the Bids to get the Overall Score for that GISTDA shall undertake the following:



Instructions to Bidders

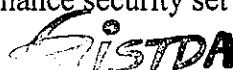
- (1) The detailed evaluation of the financial components of the bids, to establish the correct calculated prices of the bids; and
- (2) The lowest correct calculated price is then given a maximum score of 100 points. This is then used as a basis to calculate the score of the other financial proposals. The financial score for each proposal is inversely proportional to its correct calculated price, that is, the higher the correct calculated price, the lower the financial score (each of the correct calculated price = 100 points x correct calculated price of the lowest priced proposal / correct calculated price of the proposal under considerations); and
- (3) The Overall Score is calculated from $(0.8 \times \text{Technical Proposal score}) + (0.2 \times \text{financial score})$.

25.7 In case of discrepancies between:

- (1) bid price in figures and in words, the latter shall prevail;
- (2) the unit rate and the line item total resulting from multiplying the unit rate by the quantity, the unit rates as quoted will govern, unless in the opinion of GISTDA there is an obvious gross misplacement of the decimal point in the unit rate, in which case the line item total as quoted will govern, and the unit rate will be corrected.;
- (3) the total Bid amount and the sum of total costs per item, the sum of the total costs per item shall prevail and the total Bid amount will be corrected;
- (4) unit cost in the detailed estimate and unit cost in the Bill of Quantities, the latter shall prevail.

25.8 Based on the detailed evaluation of bids, those that comply with the above-mentioned requirements shall be ranked in the descending order of their Overall Scores (calculated from Technical Proposal scores and bid prices, as evaluated and corrected for computational errors, discounts and other modifications) to identify the Highest-Overall-Score Bid. Calculated bid prices, as evaluated and corrected for computational errors, discounts and other modifications, which exceed the approved budget for the contract shall not be considered.

25.9 If the bid of the successful bidder is seriously unbalanced in relation to or substantially below the Engineer's estimate of the cost of work to be performed under the Contract, GISTDA may require the bidder to produce detailed price analyses, GISTDA may require the amount of the performance security set forth in Clause 29 be increased at the expense

The logo for GISTDA (Government of India State Transport Development Agency) is located at the bottom center of the page. It features the word "GISTDA" in a stylized, bold, sans-serif font. The "G" is particularly large and has a distinctive shape, with the letters "I", "S", "T", "D", and "A" following in a similar bold style.

Instructions to Bidders

of the successful bidder to a level sufficient to protect GISTDA against financial loss in the event of default of the successful bidder under the Contract.

- 25.10 The estimated effect of any price adjustment conditions under the General Conditions of Contract, during the period of implementation of the Contract, will not be taken into account in Bid evaluation.

F AWARD OF CONTRACT

26. Award

GISTDA will negotiate with the Highest-Overall-Score bidder pursuant to Clause 25.6 for GISTDA's benefits. GISTDA will award the Contract to the successful bidder whose bid has been determined to be substantially responsive to the Bid Documents and who has succeeded in the negotiation with GISTDA. If the negotiation fails, GISTDA will then make such negotiate with the next lower Overall Score (in the descending order) pursuant to Clause 25.6 from the bidders rated "passed" pursuant to Clause 25.3.

27. GISTDA's Right to accept any Bid and to reject any or all Bids

- 27.1 Notwithstanding the eligibility of a bidder, GISTDA reserves the right to review its qualifications at any stage of the procurement process if it has reasonable grounds to believe that a misrepresentation has been made by the said bidder, or that there has been a change in the bidders' capability to undertake the project from the time it submitted its eligibility requirements. Should such review uncover misrepresentation made in the eligibility and bidding requirements, statements, or documents, or any changes in the situation of the bidder which will affect its capability to undertake the project so that it fails the preset eligibility or bid evaluation criteria, GISTDA shall consider the said bidder as ineligible and shall disqualify it from submitting a bid or from obtaining an award or contract.
- 27.2 GISTDA reserves the right to reject any and all bids, declare a failure of bidding, or not award the contract in the following situations:
- (1) If there is *prima facie* evidence of collusion between appropriate employees of GISTDA, or between GISTDA and any of the bidders, or if the collusion is between or among the bidders themselves, or between a bidder and a third party, including any act which restricts, suppresses or nullifies or tends to restrict, suppress or nullify competition;



Instructions to Bidders

- (2) If GISTDA is found to have failed in following the prescribed bidding procedures; or
 - (3) For any justifiable and reasonable ground where the award of the contract will not redound to the benefit of GISTDA as follows: (i) if the physical and economic conditions have significantly changed so as to render the project no longer economically, financially or technically feasible as determined by GISTDA; (ii) if the project is no longer necessary as determined by GISTDA; and (iii) if the source of funds for the project has been withheld or reduced through no fault of GISTDA.
- 27.3 The signing of the contract can be made only after GISTDA gets the project budget. GISTDA reserves the right to accept or reject any bid, and to annul the bidding process and reject all bids, at any time prior to award of Contract, without thereby incurring any liability to the affected bidder or bidders or any obligation to inform the affected bidder or bidders of the grounds for GISTDA's action.
- 28. Notification of Award**
- 28.1 Prior to expiration of the period of bid validity prescribed by GISTDA, GISTDA will notify the successful bidder by cable confirmed by registered letter that his bid has been accepted. The letter (hereinafter called the "Letter of Acceptance") shall name the sum which GISTDA will pay the Contractor in consideration of the execution, completion and maintenance of the Works by the Contractor as prescribed by the Contract (hereinafter called "the Contract Price").
- 28.2 The notification of award ("Letter of Acceptance") will constitute a part of the Contract.
- 28.3 Upon signing Contract Agreement and furnishing by the successful bidder of a performance security, GISTDA will promptly notify the other bidders that their bids have been unsuccessful.
- 29. Signing of Agreement**
- 29.1 At the same time that GISTDA notifies the successful bidder that its bid has been accepted, GISTDA will send the bidder the Form of Agreement provided in the Bid Documents, incorporating all agreements between the parties.
- 29.2 Within 14 days upon receipt of the notification of award ("Letter of Acceptance"), the successful Bidder shall sign the Form and submit to GISTDA:
- (1) its written confirmation to the Award;
 - (2) the Contract Form signed by the bidder;



Instructions to Bidders

- (3) the required Performance Security; and
 - (4) all other documentary requirements for the Contract.
- 29.3 Within 14 days upon receipt from the successful Bidder of the signed Forms in accordance with Sub-Clause 29.2 (the signed contract, the required Performance Security and all other documentary requirements) GISTDA shall sign and approve the contract.
- 29.4 Bidder shall ensure that its State authority, responsible for the approval of exporting THEOS-2 project to Thailand, must be eligible to execute Memorandum of Understanding between GISTDA and State authority concerned on Cooperation on the Earth Observation Satellite System for Development Project (THEOS-2) ("MOU"), details as attached in Annex 2, Form of Agreement.
- Bidder acknowledges that the execution of the MOU is condition precedent of the Procurement Contract execution. The MOU shall be executed on or before the date of execution of the Procurement Contract, otherwise GISTDA shall have no liability or obligation of any kind with Bidder regarding THEOS-2 project. In the event that the MOU could not be executed on the execution date of the Procurement Contract that has been specified by GISTDA, GISTDA reserves the rights to seek a new Bidder at GISTDA's sole discretion.
- 29.5 Bidder shall be qualified to fulfill its obligation and liability under the Procurement Contract, otherwise Bidder shall be liable to GISTDA according to the Procurement Contract.
- 29.6 Bidder shall submit the name of the State authority concerned and any official documents stating its authority, together with Technical and Performance Specification Proposal.

30. Performance Security

- 30.1 Within 14 days of receipt of the notification of award ("Letter of Acceptance") from GISTDA, the successful bidder shall furnish to GISTDA a performance security in an amount of 5 percent of the Contract Price in accordance with the Conditions of Contract. The performance security shall be in one of the following:
- (1) Cash; or
 - (2) Cashier's Cheque payable to GISTDA; or



Instructions to Bidders

- (3) An Irrevocable letter of credit or bank guarantees issued by a bank which is registered and authorized to do business in Thailand or a foreign bank through a correspondent bank in Thailand and in the format included in ANNEX 3; or
- (4) An Irrevocable letter of credit or bank guarantees issued by a finance company that has been granted a license to carry out commercial investment and guarantee business as announced by the Bank in Thailand in the format included in ANNEX 3; or
- (5) Thai Government Bond;
- (6) Bank Draft

The form of performance security provided in ANNEX 3 of the Bid Documents is to be used.

30.2 Failure of the successful bidder to comply with the requirements of Clauses 28 or 29 shall constitute sufficient grounds for the annulment of the award and forfeiture of the bid security. In which event, GISTDA shall award the contract to the second Best Evaluated Bid Price and so on.

30.3 Upon the furnishing by the successful Bidder of the Performance Security, GISTDA will promptly notify the other Bidders that their Bids have been unsuccessful.

The Performance Security shall be returned without interest when the successful bidder (the Contractor) has fulfilled all contract obligations.

31. Notice to Proceed

Within thirty (30) days from the date of issuing the Letter of Acceptance, GISTDA shall issue its Notice to Proceed/Commence.

32. Advance Payment Security

GISTDA will provide an Advance Payment on the Contract Price subject to a maximum amount of 15% of the Contract Price.



Instructions to Bidders

ANNEX 1A

FORM OF BID

Name of Contract* THEOS-2

To: Executive Director
Geo-informatics and Space Technology Development Agency (Public Organization)
120 The Government Complex Commemorating His Majesty The King's 80th Birthday Anniversary, 5th December, B.E. 2550 (2007)
Ratthaprasasanabhakti Building 6th and 7th Floor, Chaeng Wattana Road, Lak Si Bangkok 10210, Thailand

Gentlemen:

1. Having examined the Specification, Drawings, and Bill of Quantities and Addenda Nos. _____ for the execution of the above-named Works, we, the undersigned, offer to execute and complete such Works and remedy any defects therein in conformity with the Specification, Drawings, Bill of Quantities and Addenda for the sum of _____ Baht (in figure) (Baht _____) (in words) as specified in the Appendix to Bid or such other sums as may be ascertained in accordance with the said Conditions and or relevant documents.
2. We acknowledge that the Appendix forms part of our Bid.
3. We undertake, if our Bid is accepted, to commence the Works as soon as is reasonably possible after the receipt of GISTDA's notice to commence/proceed, and to complete the whole of the Works comprised in the Contract within the time stated in the Appendix to Bid.
4. We agree to abide by this Bid for the period of 270 days from the date fixed for receiving the same, and it shall remain binding upon us and may be accepted at any time before the expiration of that period.
5. Unless and until a formal Agreement is prepared and executed this Bid, together with your written acceptance thereof, shall constitute a binding contract between us.
6. We understand that you are not bound to accept the lowest or any Bid you may receive.

Date this _____ day of _____ (state year)

Name: _____

In the capacity of _____

Sign: _____

Duly authorized to sign Bids for an on behalf of _____

[in block capitals or typed]

Address: _____

Witness: _____

Address: _____

Occupation: _____

The logo for GISTDA (Geo-Informatics and Space Technology Development Agency) is located at the bottom center of the page. It features the word "GISTDA" in a stylized, bold, sans-serif font. The letter "G" is particularly large and has a unique, rounded shape. The letters "I", "S", "T", "D", and "A" are smaller and more standard in shape. The overall logo is black and white.

ANNEX 1B

FORM OF BID SECURITY

BY THIS BOND dated _____ the _____ day of 200 _____ [_____] of/whose registered office is at [_____] (the “**Surety**”) is irrevocably and unconditionally bound to the Geo-Informatics and Space Technology Development Agency (Public Organization) (together with its successors and assigns, “**GISTDA**”) for payment of a sum of _____ [_____] million Thai Baht [_____] (the “**Bonded Sum**”) in accordance with the provisions of this Bond.

WHEREAS:

- (a) GISTDA has invited bids for the procurement of the Satellites and relevant services under Thailand Earth Observation System – 2 Project (THEOS-2) by its letter of invitation to bidders dated [_____] for contract in relation to the THEOS-2 Project (the “**Letter of Invitation to Bid**”);
- (b) [_____] (the “**Bidder**”) has submitted its response (the “**Bid**”) to the Letter of Invitation to Bid.
- (c) In consideration of GISDTA supplying to the Bidder the draft contract documents and agreeing to examine and consider the Bid, the Bidder has agreed to keep the Bid open for acceptance without unilaterally varying or amending the terms thereof for the period stated therein and, if the Bid is accepted, to provide a performance bond as security for the due performance of the contract thereby formed in accordance with Clause 12(1) of the General Conditions of Contract (together the “**Bid Obligations**”) and to provide a Bond in the terms hereof.
- (d) At the request of and for the account of the Bidder, the Surety has agreed to guarantee to GISTDA the due performance by the Bidder of the Bid Obligations.

NOW THE TERMS AND CONDITIONS of this Bond are:

- 1. The Surety hereby irrevocably and unconditionally undertakes to pay to GISTDA the sum of [_____] million Thai Baht [_____] upon receipt from GISTDA of a written demand therefore accompanied by a certificate signed by the GISTDA Executive Director or, in his absence, the person acting in his stead on behalf of GISTDA stating that the Bidder is in default of one or other of the Bid Obligations.
- 2. The Surety shall pay to GISTDA forthwith the amount thus demanded without requiring further evidence or proof of the default of the Bidder.
- 3. The liability of the Surety under this Bond shall remain in full force and effect and shall not be affected or discharged in any way and the Surety hereby waives notice of:-
 - (a) any amendment to the Bid by agreement between GISTDA and the Bidder or any concession or waiver by GISTDA in respect of the Bid Obligations;
 - (b) the Bid or any provision of the Bid being or becoming illegal, invalid, void, voidable, or unenforceable;



Instructions to Bidders

- (c) after notification of acceptance of the Bid, the contract thereby formed or any provision of such contract being or becoming illegal, invalid, void, voidable or unenforceable;
 - (d) any forbearance or waiver of any right of action or remedy GISTDA may have against the Bidder or negligence by GISTDA in enforcing any such right of action or remedy.;
 - (e) any other bond, undertaking, security or guarantee held or obtained by GISTDA for any of the Bid Obligations or under the contract formed by acceptance of the Bid or any release or waiver thereof;
 - (f) any act or omission of the Bidder pursuant to any other arrangement with the Surety.
4. The liability of the Surety under this Bond shall cease on whichever of the following events first occurs:-
- (a) Payment by the Surety of the Bonded Sum in full to GISTDA; or
 - (b) Notification in writing by GISTDA to the Bidder of the termination of the bidding process for Contract [CONTRACT NO.]; or
 - (c) Acceptance by GISTDA of any other bid for Contract [CONTRACT NO.]; or
 - (d) The expiry of 90 days after the latest date for acceptance of the Bid specified in Appendix 1 to the Form of Bid or of such further period as the Surety may specify by notice in writing to GISTDA in the absence of prior service of a demand under this Bond; or
 - (e) Provision by the Bidder subsequent to acceptance of the Bid of a performance bond in respect of its obligations under and in accordance with the terms of the Contract formed by acceptance of the Bid.
5. GISTDA shall be entitled to assign the benefit of this Bond at any time without the consent of the Surety or the Contractor being required.
6. All documents arising out of or in connection with this Bond shall be served:-
- (a) Upon GISTDA, [____], Thailand marked for the attention of The Executive Director, GISTDA;
 - (b) Upon the Surety, at [____] Thailand¹
7. GISTDA and the Surety may change their respective nominated addresses for service of documents to another address in Thailand but only by prior written notice of each other. All demands and notices must be in writing and must be served by hand.
8. This Bond shall be governed by and construed according to the laws for the time being in force in Thailand and the Surety agrees to submit to the non-exclusive jurisdiction of the courts of Thailand.

IN WITNESS whereof this Bond has been executed as a deed on the date first before written.

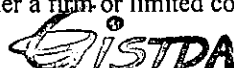
THE COMMON SEAL OF [_____] was affixed hereto in the presence of:-

[_____]

or SIGNED, SEALED AND DELIVERED² for and on behalf of and as lawful attorney of the Surety under power of attorney dated [_____]

¹ The address for service shall be in Thailand.

² For use where the Surety, whether a firm or limited company, executes through an attorney.

The logo of GISTDA (Government Information Systems Training and Development Agency) is located at the bottom center of the page. It features the word "GISTDA" in a stylized, bold, sans-serif font. The letter "G" is particularly large and has a circular design element around it. The letters are black.

Instructions to Bidders

by []

in the presence of: []

GISTDA

ANNEX 2

FORM OF AGREEMENT

This Agreement made this _____ day of _____ (state month and year) between Geo-informatics and Space Technology Development Agency (Public Organization) ("GISTDA"), Ministry of Science and Technology, Government of the Kingdom of Thailand (hereinafter called the "**Employer**") of the one part and _____ of _____ (hereinafter called the "**Contractor**") of the other part.

Whereas the Employer is desirous that the procurement of the Satellites and relevant services under Thailand Earth Observation System – 2 Project (THEOS-2) (the "**Works**") should be executed by the Contractor, viz. _____ and has accepted a Bid by the Contractor for the execution and completion of such the Works and the remedying of any defects therein.

Now this Agreement witnesses as follows:

1. In this Agreement words and expressions shall have the same meanings as are respectively assigned to them in the Conditions of Contract hereinafter referred to.
2. The following documents shall be deemed to form and be read and construed as part of this Agreement, viz.:
 - a. The Letter of Acceptance;
 - b. The said Bid;
 - c. The Conditions of Particular Application (Part 11);
 - d. The General Conditions (Part I);
 - e. The Specifications;
 - f. The Drawings;
 - g. The Priced Bill of Quantities; and
 - h. The Schedules of Supplementary Information.
3. In consideration of the payments to be made by the Employer to the Contractor as hereinafter mentioned, the Contractor hereby covenants with the Employer to execute and complete the Works and remedy any defects therein in conformity in all respects with the provision of the Contract.
4. The Employer hereby covenants to pay the Contractor in consideration of the execution and completion of the Works and the remedying the defects therein the Contract Price or such other sum as may become payable under the provisions of the Contract at the times and in the manner prescribed by the Contract.

In Witness whereof the parties hereto have caused this Agreement to be executed the day and year first before written.

SIGNED by:

for and on behalf of the Employer in the presence of

SIGN by:

for and on behalf of the Contractor in the presence of

The logo for GISTDA (Geo-Informatics and Space Technology Development Agency) is located at the bottom center of the page. It features the word "GISTDA" in a stylized, italicized font, with a small circular emblem containing a star-like shape above the letter 'I'.

Instructions to Bidders

Witness:

Name:

Address:

Date:

Witness:

Name:

Address:

Date:

GISTDA

Instructions to Bidders

ANNEX 3

FORM OF SECURITIES

FORM OF ADVANCE PAYMENT GUARANTEE³

No.

Date:

WHEREAS [Name of Contractor] (hereinafter called the "CONTRACTOR") has entered into a Contract with the Geo-Informatics and Space Technology Development Agency (hereinafter referred to as "GISTDA") to undertake [Name of the Contract] as per Contract No. [] executed on whereby the Contractor is entitled to draw an advance money of Baht [Amount in Word] which is equivalent to [] percent ([])% of the Contract cost.

WHEREAS the CONTRACTOR wishes to draw the said advance money of [AMOUNT] from GISTDA against presentation of a Bank Guarantee for the same amount.

NOW THEREFORE, by this letter of Guarantee, we [Name Of Commercial Bank In Thailand or local Thai branch of International Commercial Bank] Business Address No. Sub-District District Province hereby agree to guarantee to GISTDA under the conditions set below:

(1) We hereby guarantee repayment of the advance money received by the CONTRACTOR to the extent of Baht [..... AMOUNT] (.....).

(2) If the CONTRACTOR is required to refund the advance money stated in Clause 1 above in case where the CONTRACTOR acts contrary or fails to act in accordance with the Contract thereby resulting in a breach of the Contract, we hereby agree to repay the said advance money, without whatsoever right of objection on our part, to GISTDA within 7 [seven] days from the receipt of written request to do so from GISTDA stating that the CONTRACTOR has failed to remedy said breach after due notice without the necessity of previous request to the CONTRACTOR for repayment of the same without whatsoever right of objection on our part.

(3) If, at any time in the course of the execution of the Contract, GISTDA grants a time extension, or allows the CONTRACTOR to deviate from any terms and conditions of the Contract without our knowledge, it shall be deemed that such grants shall have been made with our consent

(4) We shall in no event withdraw this Letter of Guarantee for any reason so far as the last payment under the Contract has not been made to the CONTRACTOR.

IN WITNESS WHEREOF, we [Name of the Bank] have caused these presents to be signed by our authorized representative and our corporate seal to be hereinto affixed.

[Signed]

Guarantor

(.....)

3

Subject to amendment as per the applicable Thai law.

GISTDA

Instructions to Bidders

[Signed]

Witness

(.....)

GISTDA

FORM OF PERFORMANCE GUARANTEE⁴

No.

Date:

We, [Name of a Commercial Bank in Thailand or Thai branch of an International Commercial Bank] hereinafter referred to as the "Guarantor" hereby establish this letter of guarantee in favour of the Geo-Informatics and Space Technology Development Agency (hereinafter referred to as "GISTDA") as follows:

(1) As [Name of the Contractor] (hereinafter referred to as the "CONTRACTOR") has entered into contract for [Name of the Contract] under the Contract No. dated whereby the CONTRACTOR has to deposit with GISTDA earnest money as performance security for the proper and faithful performance of the Contract in the Amount of Baht [in words] equivalent to 5% (five percent) of the total contract value, we agree unconditionally to irrevocably guarantee as primary obligor, the payment to GISTDA on its first demand, without whatsoever right of objection on our part, an amount not exceeding Baht [in words] in the event of any damages, liquidated damages or expenses actually due by the CONTRACTOR or if a material obligation in the above mentioned Contract has not been fulfilled by the CONTRACTOR.

(2) If, at any time in the course of the execution of the Contract, GISTDA grants a time extension, or allows the CONTRACTOR to deviate from any conditions of the Contract without our knowledge, it shall be deemed that such grants shall have been made with our consent.

(3) This Letter of Guarantee shall be valid from the date of execution of the abovementioned Contract until all obligations on the part of the CONTRACTOR have been fulfilled.

IN WITNESS WHEREOF, we [Name of the Bank] have caused these presents to be signed by our authorized representative and our corporate seal to be hereinto affixed.

[Signed] _____ Guarantor
(.....)

[Signed] _____ Witness
(.....)

[Signed] _____ Witness
(.....)

⁴ Subject to amendment as per the applicable Thai law.

Instructions to Bidders

ANNEX 4

PRICING DOCUMENT

Item	Description	Unit	Rate	Price (BAHT)
1	Provision of External Data			
1.1	● Project Implementation Phase (per year)			
1.2	● (Optional) Project Operation Phase (per year)			
2	Solutions and Applications			
2.1	● Technical Personnel			
2.1.1	- Local			
2.1.2	- Expatriate			
2.2	● Architecture & Design			
2.3	● Hardware			
2.4	● Software			
2.5	● Project Management			
3	Satellite Systems			
3.1	● Main Satellite			
3.2	● Small Satellite			
3.3	● Control Ground Segment			
3.4	● Image Ground Segment			
3.5	● TT&C Facilities and Receiving Stations			
3.6	● Archive and Catalogue			
3.7	● Image processing ground segment / Image processing			
3.8	● Mobile Ground Segment			
3.9	● Dual-use operation			
3.10	● Launch of Main Satellite			

Instructions to Bidders

Item	Description	Unit	Rate	Price (BAHT)
3.11	Launch insurance of Main Satellite			
3.12	Launch of Small Satellite			
3.13	Launch insurance of Small Satellite			
4	IT Infrastructure Design			
5	Capacity Building, Technology Transfer and Training			
5.1	- Capacity Building and Technology Transfer			
5.2	- Training			
5.3	- Engineering Model			
6	Maintenance / Support Per Year			
7	Ground receiving station backup			
8	Other platforms (specify)			

APPENDIX 1: BACKGROUND

1 Spatio-temporal problems and the needs to overcome (as stipulated in this TOR)

Thailand, with an area of 513,115 square kilometers or around 320 million rai⁵, is subjected to both major area-based and time-based (spatio-temporal) problems. These problems comprise forest encroachment, drought, flood, forest fire, earthquake, land subsidence, landslide, coastal erosion, urban crowdedness, pollution, illegal fishing, improper taxation with respect to area and utilization, improper land use for cultivation and man-made problems either from buildings / constructions or from improper management both in agriculture and industry sectors.

There have been several approaches to solve these problems. Government and private sectors have been using remote sensing technology due to the fact that it can provide real time updates of the area with time and frequency of observation determined by the characteristics of the sensing equipments. Observation systems can acquire information of large and hazardous areas that are difficult to access and can acquire spectral range much greater than human visibility spectrum. Nowadays, remote sensing and space technology are applied to different fields including agriculture, industry, ecology and natural resources management, water management, disaster management, and national security. Applications are given as examples below; together with the needs to overcome in this TOR.

- Forest encroachment detection by analyzing satellite imagery and aerial photos from subsequent years in order to detect forest area change. The detection is needed to be near real-time is our intent in this TOR.
- Disaster management by connecting ground-based information from government and private organizations in order to monitor, issue early warning and help mitigate the problem. The emergency systems and disaster phenomena are needed to be efficiently integrated in this TOR.
- Agriculture management by using satellite imagery, aerial photos and sensors to monitor the cultivating area, perform crop planning and calculate crop damage compensations from pests, natural disaster and others. Such arisen management model has not yet embraced demand-supply dynamics.

The sector-based solution or application operations are conducted separately according to each agency's or organization's mandates with some degrees of agency cooperation. This is not

⁵ 1 rai = 1,600 square meters

sufficient for area-based decision-making system for the country. It is thus required in this TOR to develop such a system that will efficiently integrate specific or individual solutions operated by each agencies / organizations into integrated solution systems.

2 System Integration from Satellite-GIS technology to integrated solutions; all, towards Actionable Intelligence Policy (AIP)

Actionable Intelligence-focused Remote Sensing in this TOR puts focus on elements of spatial, spectral, and temporal signature collection in the visible and infrared, including imagery interpretation, thermal, reflective, and polarimetric target characterization, radiative transfer, advanced technical intelligence collection systems, and integrated solution processing, analysis, and trend techniques.

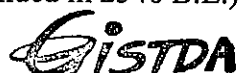
The platform to be proposed is capable of monitoring networks is no longer enough for the ability is needed to rapidly deal with changing conditions like evolving weather patterns or other catastrophic hits. Intelligence is to provide real-time data and intelligent analysis across the entire network in order to provide deeper visibility and overall solutions to the targets areas: such an intelligent system is required in the proposal.

3 Existing Thailand Earth observation system

Thailand has been utilizing satellite remote sensing data for observation of natural resources for more than 40 years. In the early years, it received image data from international satellites for earth observation data interpretation and analysis. In 2525 B.E. (1982), the National Research Council of Thailand established the LANDSAT receiving station, the first satellite receiving station in Southeast Asia located in Lad Krabang district, Bangkok. The Lad Krabang receiving station has been occasionally upgraded to receive image data from several international satellites, e.g. those from United States, France, Japan, India and Canada.

In 2541 B.E. (1998), Thailand launched a 50 kilograms educational Earth Observation microsatellite, ThaiPaht (TMSat-1). This microsatellite was co-developed by Mahanakorn University of Technology and Surrey Satellite Technology Ltd. (SSTL), UK. Under this program, 12 Thai engineers were participated.

In 2547 B.E. (2004), the Ministry of Science and Technology (MOST), by GISTDA, signed a contract with EADS ASTRIUM, France to develop the THEOS (Thailand Earth Observation System) project. The satellite called THEOS, also in Thai called Thaichote, was developed under Government-to-Government collaboratorial agreement between Thailand and France, signed in 2543 B.E. (extended in 2546 B.E.).

The logo for GISTDA (Geospatial Information Science and Technology Development Agency of Thailand) is displayed. It features the word "GISTDA" in a stylized, bold, sans-serif font. The letter "G" is particularly large and has a distinctive shape, with a horizontal line extending from its top. The letters "I", "S", "T", "D", and "A" are smaller and follow a similar bold, sans-serif style.

Instructions to Bidders

Thaichote is an Earth observation satellite that weighs about 720 kilograms, orbiting at approximately 820 km altitude with 26 days repetitive cycle. The satellite was designed for the minimum of 5 years lifetime. The payloads comprise a panchromatic telescope with 2m resolution / 22 km swath width and a multispectral camera (B, G, R, NIR) with 15m resolution / 90 km swath width (at NADIR pointing).

THEOS (Thaichote) Characteristics

Imager	Panchromatic	Multispectral
Spectral Bands	P : 450 - 900 nanometer	B1 (Blue): 450 - 520 nanometer B2 (Green): 530 - 600 nanometer B3 (Red): 620 - 690 nanometer B4 (Near Infrared): 770 - 900 nanometer

THEOS or Thaichote was launched into orbit on October 1, 2551 B.E. (2008) and officially provided image data services to both national and international users on June 1, 2552 B.E. (2009). It is the first operational Earth Observation satellite in Thailand and Southeast Asia and is the main satellite of Thailand Earth Observation system. It is expected that Thaichote could maintain its operation at least beyond 2018.

In 2554 B.E. (2011), Kasetsart University built a satellite receiving station under Thailand – People's Republic of China collaborative SMMS (Small Multi-Mission Satellite) program. It receives signal from HJ-1A and HJ-1B satellites mainly used for research, agriculture and disaster monitoring.

GISTDA also set up the Space Krenovation Park (SKP) at Si Racha, Chonburi in 2555 B.E. (2012) The SKP serves as a platform for linking each of satellite ground systems to the infrastructure for research and space innovation development, incubation center for technology and innovation and training center. The objectives of SKP include

- 1) Being national infrastructure for supporting and promoting research in space technology and geo-informatics in both software and hardware, for commercial products and applications development based on R&D collaborations with national and international universities, industry sector and community
- 2) Being a basis for further development in order to create commercial values to products related to space technology and geo-informatics which is to be extended to business sectors, Small and Medium Enterprises (SME), and the industry. Success in such development will place Thailand among the leaders in ASEAN in business development based on science, technology and innovation.



- 3) Being a hub supporting space and geo-informatics knowledge and technology transfer to industry and education sectors by using science, technology and innovation infrastructure and alliance networks both in Thailand and international.

As such, SKP will serve as one of the main platforms and infrastructure for the development and operation of THEOS-2.

Apart from Thaichote, Thailand ground receiving stations are currently receiving image data from several satellites including COMS, COSMO-SkyMed, HJ-1A/1B, LANDSAT-8, MetOp-A/B, MTSAT-2, NPP-Suomi, NOAA-16/18/19, RADARSAT-2 and Terra/Aqua.

In addition, Thailand has contracts to access the satellite imagery from Airbus Defence & Space (Pleiades 1A-B, SPOT 6-7, TerraSAR-X, TanDEM-X), Black Sky Global, DigitalGlobe (GeoEye, Ikonos, QuickBird, WorldView 1-3) and Kompsat 2,3,5.

4 Values and Limitations from past developments

Developments and utilizations of satellite data of specific application in the past were of specific application, not holistically integrated and implemented in a long-term national plan. The scope of the THEOS project (Thaichote satellite) did not cover application system development and lacked a system designed to solve problems in a coherent manners.

Thaichote corporate training program provided at the supplier premise had its limitations in technology transfer, participation in satellite design and integration and lacking true capacity building plan for specialists. There was no subsequent solution development programs to maximize the satellite infrastructure and realizing the state of art technology. From this experiences and lesson-learned, THEOS-2 program shall start from focusing on full participation in all activities of satellite design, assembly, integration and test. The program shall also focus on extensive technology transfer and hands-on experiences. In addition, there shall be a parallel program to build a small satellite in Thailand and a short-to-medium term plan prepared for the trained personnel. The above statements reflect requirements in this TOR.

Furthermore, Thaichote satellite system constitutes proprietary technology which deters access to many system components, hinders system management and requires high maintenance cost. System enhancement and further development is also costly and cannot be performed without relying on the original supplier, e.g. additional installation of ground receiving and data processing system. This deficiency should be overcome to a considerable extent in THEOS-2 procurement.



Nevertheless, over the past 8 years, Thailand has gained a great benefit from THEOS and created additional values by Thaichote satellite, i.e. to evolve from only image processing and data interpretation to image data analysis and GI applications. Thaichote's image data was also being used for several policy responses in many situations, e.g. agricultural application: rice yield prediction, crop monitoring, disaster monitoring both terrestrial and maritime, forest and coastal area monitoring and national security support.

Owning and having full control of a satellite system has granted an opportunity for Thailand on research and development of space-related hardware and software, e.g. an antenna system for satellite control and satellite control software. It also leads to international collaboration in the area of satellite image and technology exchange.

5 Strategic ways forward

- THEOS-2 Program is not to be handled or owned by any single organization/ sector. It shall serve and respond to demands from both public and private sectors. THEOS-2 project will be regarded as a development of national infrastructure on science and technology based on and compatible with the existing systems by utilizing the current equipment and infrastructure wherever feasible/ suitable. THEOS-2 system shall be configurable/ modifiable for further development.
- THEOS-2 shall focus on the whole value chain from upstream to downstream. The upstream consists of satellite and image data from satellite constellation. The midstream consists of satellite control and receiving station, standard-product image processing system, archives, and system for data access and dissemination. The downstream consists of the development of models for analysis and synthesis, development of application system and solution system for area-based management and decision-making that support multi-level user access from policy-level to local users. The THEOS-2 shall connect and integrate GIS data of land, air and water from related organizations and data monitoring stations.
- THEOS-2 shall focus on the development of (1) Area-Based Decision Making Solution Platform that supports planning, decision and command, monitoring and evaluation and (2) Integrated GI Solutions and Applications.
- Satellite control station, satellite receiving station and image data processing system shall be an integrated multi-mission system. Current and future archives (and

catalogues) shall be integrated. In addition, the system shall support cloud-free/very low cloud content image acquisition.

- The program development shall focus on national capacity building. Thai participants shall fully and extensively participate in the design, assembly, integration and test during the satellite(s) and the Earth Observation system development including the launch activity. The capacity building shall focus on hands-on trainings and fully participation, not merely observations.
- The development of a small satellite and an engineering model shall be performed in Thailand and focus on learning by practicing. It shall emphasize and promote collaboration among related organizations and local industry throughout the entire development phase.
- Capacity building in user organizations shall be performed so as to fully utilize the data, products and applications of the system.
- There shall be no blockage to data or components that deters system utilization and further development. Interface control drawings/schematics and interface control document shall be provided.

6 Objectives of THEOS-2

- 1) Devise an integrated area-based solution enabler platform by leveraging remote sensing technology, geo-spatial technology and big data analytics to address key priorities of Thailand as mentioned in the 20-year National Strategic Action Plan (2017-2036) and the 12th National Economic and Social Development Plan and conceptually depicted in Fig. 1 (Appendix 2).
- 2) Being the national collaborative project among agencies, developers and user organizations having their missions on applying geo-informatics in economic, social and environment aspects.
- 3) Being the national science and technology infrastructure for technology transfer and capacity building on geo-informatics and space technology.

APPENDIX 2: PRELUDE TO INSIGHT OF BID REQUIREMENT CONTEXT (INSTRUCTIONS TO BIDDERS)

1 Overall Scope of Work of Space-GIS Integrated Platform

1.1 Preamble : The Country Needs

For Thailand to continue the development path and to conform with global vision of the 2030 Agenda for Sustainable Development - an integrated, indivisible Actionable Intelligence Policy (AIP) must be devised to achieve such sustainable development in three dimensions – economic, social and environmental: ESE – in a balanced value system. While the ESE agenda itself is of global conformance, the platform requires to take Thai national conditions and local realities into consideration. These global goals and targets are now taken into the 12th National Economic and Social Development Plan processes and strategies as per priorities. This is simplified in Fig.1.

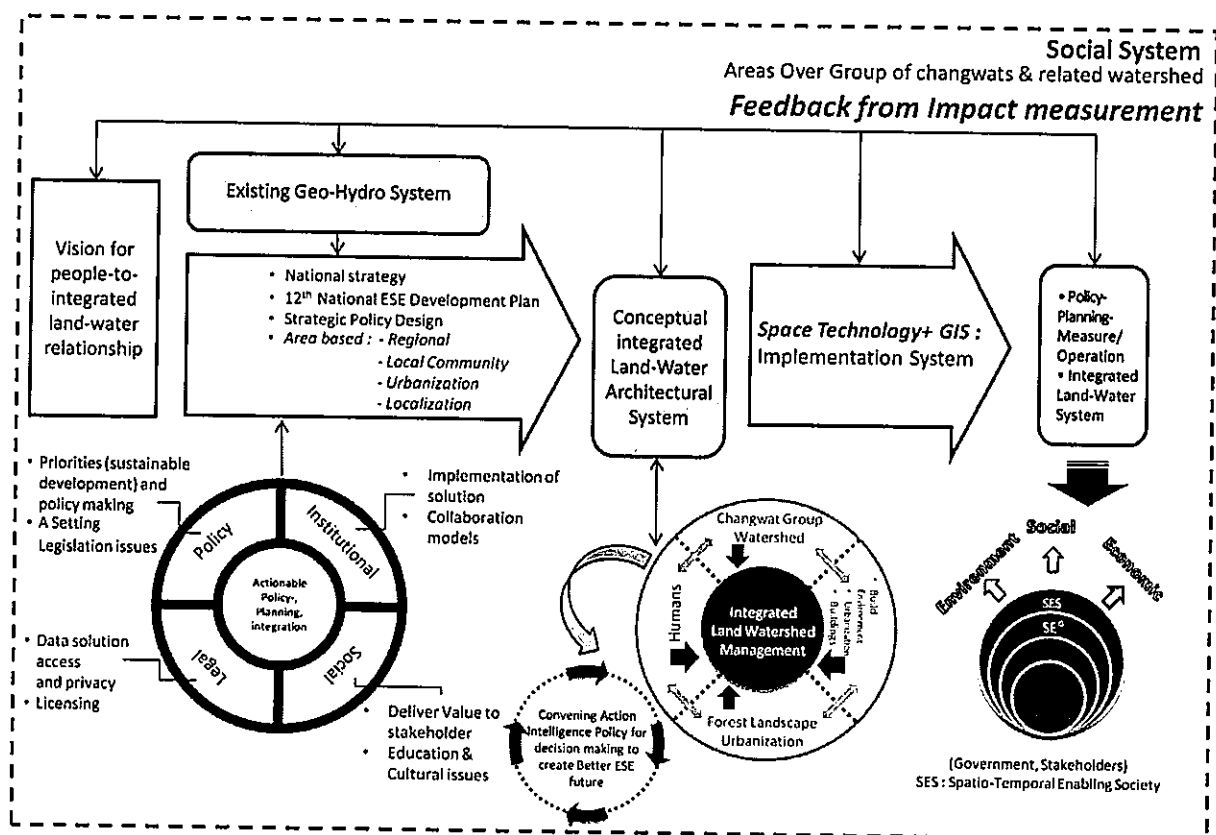


Fig. 1 Space GIS Technology as enabled value creation in the national strategy as in the 12th National Economics and Social Development Plan

1.2 Proposal in Anticipation

The proposal required to take advances in space technology, sensor, geospatial technology, communications and IT. This must lead up to any exponential increase, adding to the volume and types of solutions needed on the planet earth.

The proposal must make use of comprehensive and accurate location-based information drawn from high resolution satellites and others aerial-earth observation as external data sources where required, to support monitoring and measuring outcomes. The use of drones for areas, for example, over farm-level observations is to be incorporated and proposed. Collected information at local, national and regional levels, and supported by earth observation data together with, IT tools and other best available technologies, must be proposed to provide insightful role in monitoring targets, tracking the progress and helping countries to make mid-term adjustment to sustainable development goals and targets. When combined with demographic and geographic, these information at local areas and geo-analyses must enable the country to monitor change over a period of time towards forming Actionable Intelligence Policy (AIP) and making due decisions. Conceptual platform requirement is provided in Fig. 2 as our strategic intent and basis for explaining overall TOR.

Also, the kind of holistic Executive Support System is provided in Fig. 3 as related to Sustainable Development in Thailand, being expected in the proposed solution design and implementation.

Provisions of the integrated solutions are made in Fig. 4 being prior requirement to be completely designed at the time of THEOS-2 construction period; prior to launching the satellites into orbit.

Instructions to Bidders

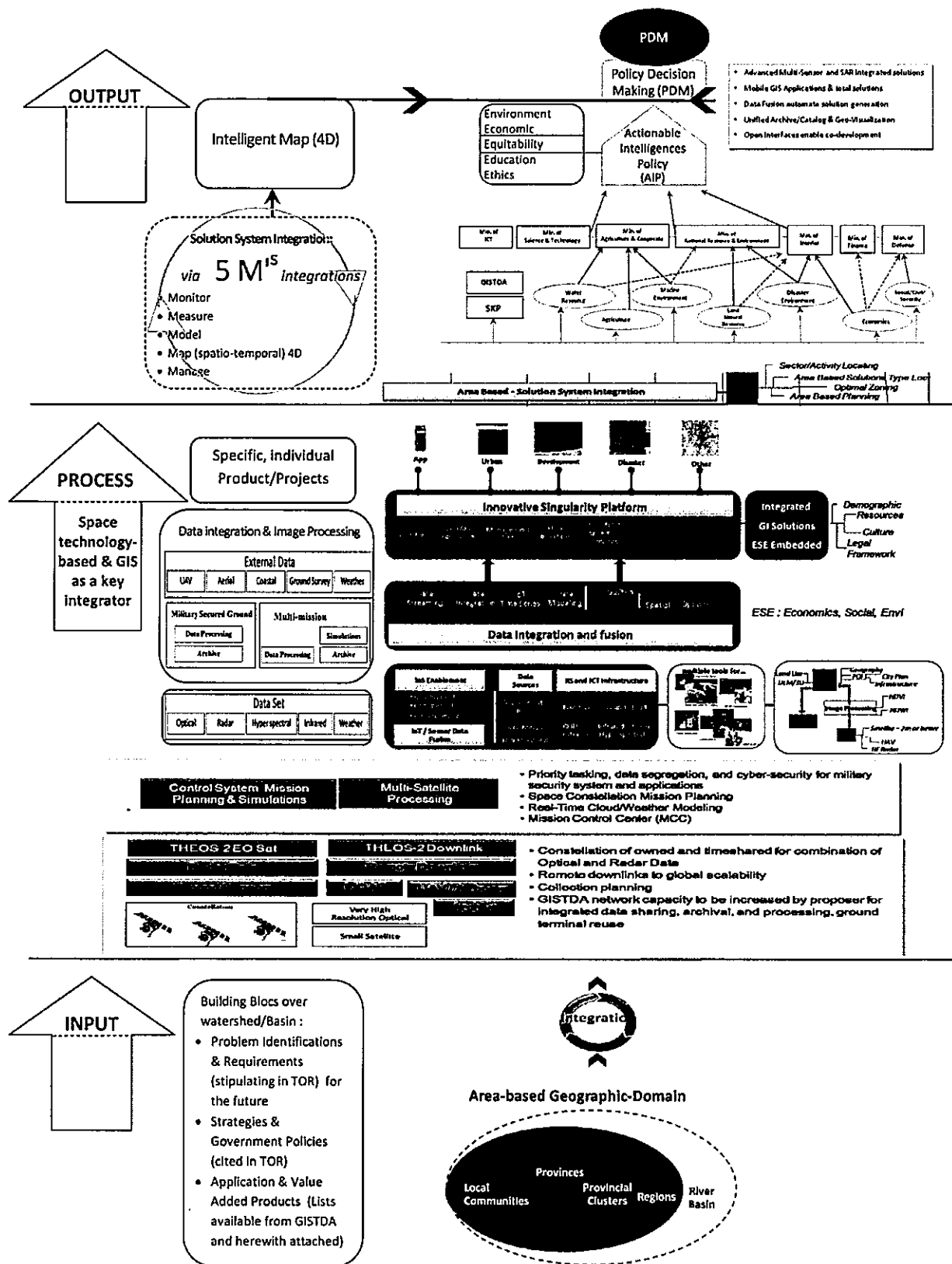


Fig. 2 Conceptual Architecture of Space-GIS Integrated Solution Platform required in this TOR SJ: 10/07/'16

Holistic Executive Support System for Sustainable Development in Thailand

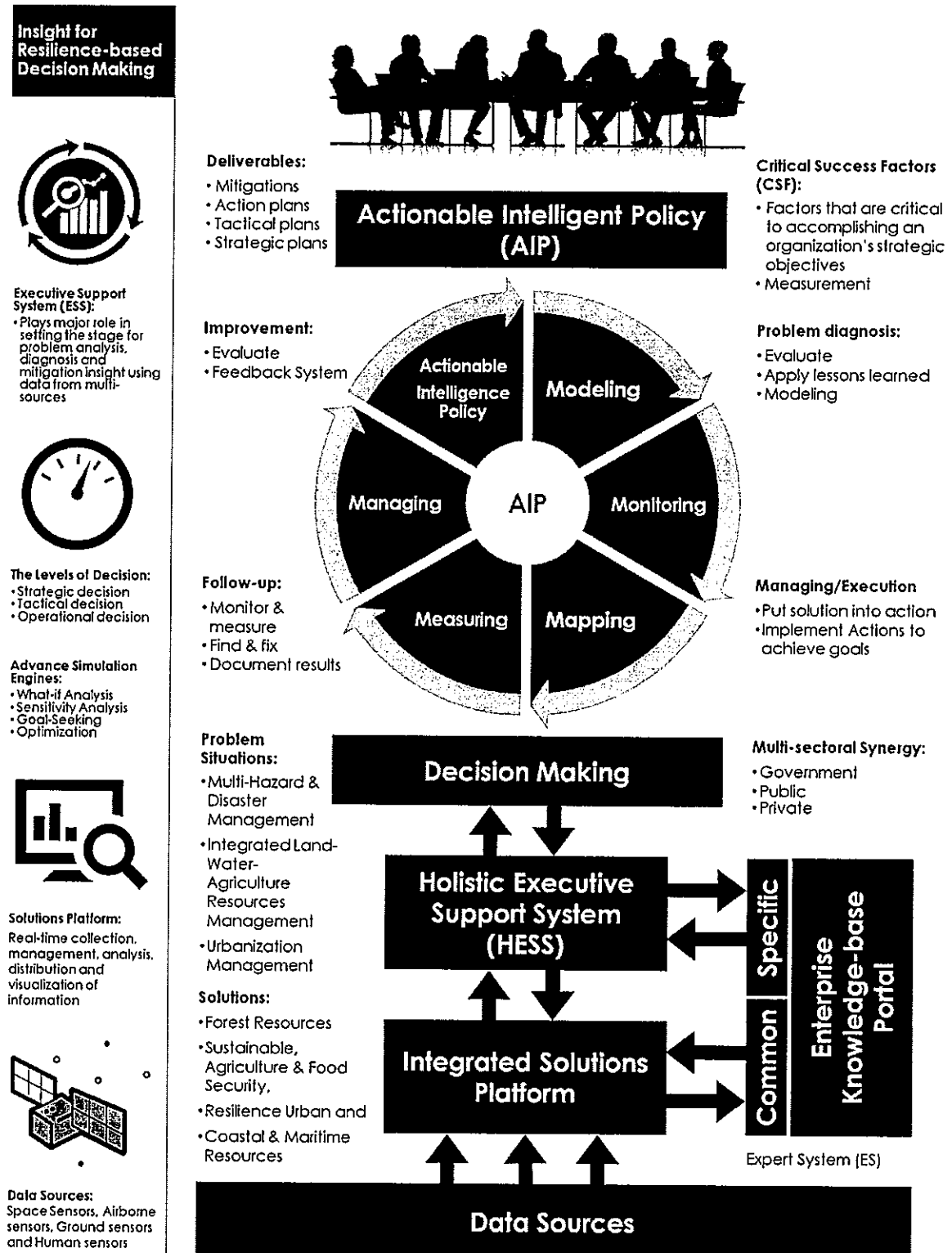
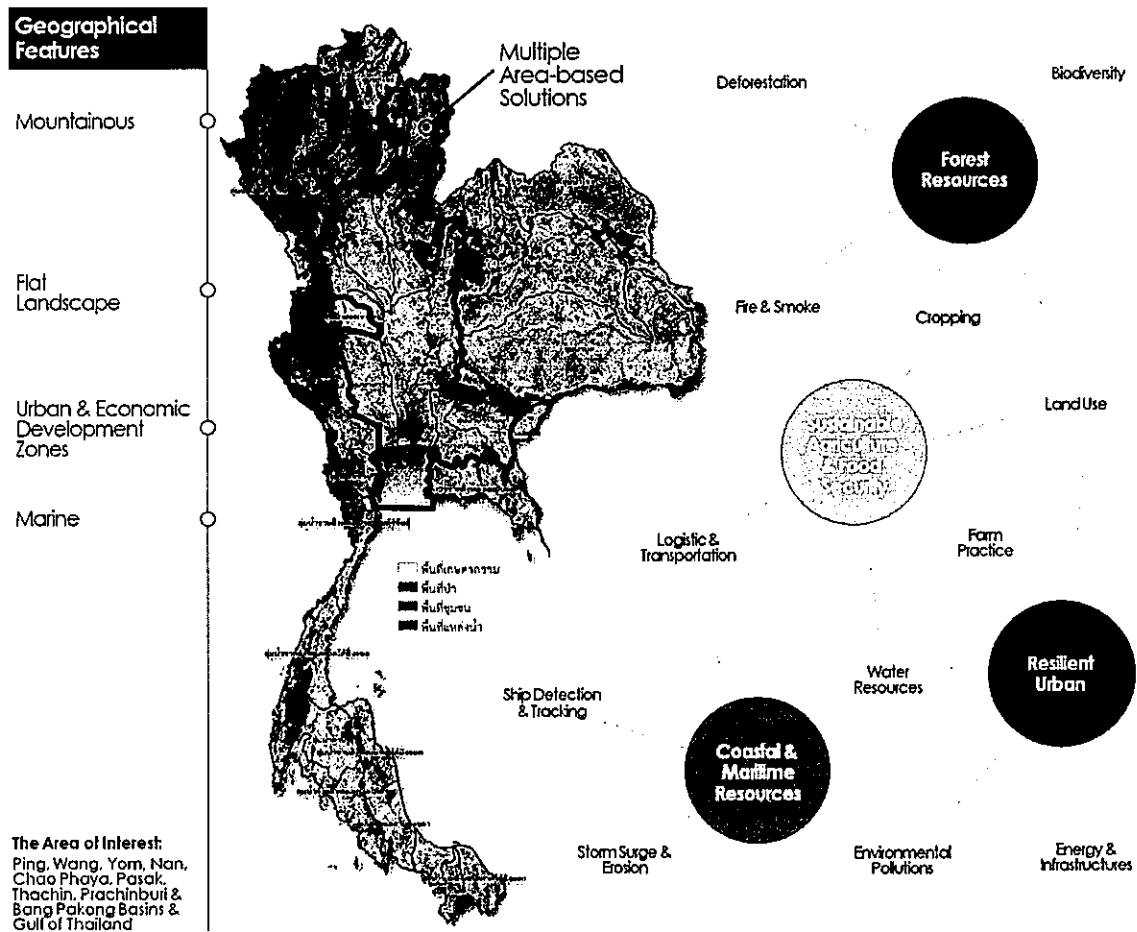


Fig 2 Holistic Executive Support System for Sustainable Development In Thailand relevant to TOP

Integrated Solutions Platform for Sustainable Development in Thailand



THEOS-2 : Integrated Solutions Platform Development

Solutions Design:
The designed solutions shall be able to support the entire area-based management, planning, decision and command, monitoring and evaluating, in association with Critical Decision Factors (CDFs)

Solution platform for developing area-based solutions is aimed for planning, decision and command, monitoring and evaluation taking into account of the social, economic and environmental impacts; in order to achieve 3 major objectives: security, prosperity & sustainability

	Conformance-national Policy Priorities	National Targets	Sub-solution/Application Interfaces	Actionable Plan/Policy Intelligence
National Sustainable Development	Forest Resources	40% Forest Area 20-25% Reduction in GHG Emission (COP21) < 50 µg/m3 of PM10 from Smoke & Haze	- Deforestation Management - Forest Zoning & Planning - Forest & Biodiversity Management - Forest fire & Agricultural Burning Management	Space-based Policy Decision Making (SPDM) Integrated Land-Water-Agriculture Resources Management
	Sustainable Agriculture & Food Security	+10% GDP (Agriculture) Reducing Cost of Damage from Disasters Increasing Food Safety & Quality	- Agricultural Zoning & Planning - Crop Monitoring - Integrated Water Management (IWM) - Flood & Drought Management - Logistic Management - Precision Farming	 Deliverables - Guideline & Manual - Mitigation (Short & long terms) - Action plan - Tactical plan - Policy & Strategic plan
	Resilient Urban	Improving the Quality of Life Good Environmental Quality High Social Security	- Urban Planning - Urban Flood Management - Intelligent City Management - Traffic Management - Air & Water Quality Management	Deliverables - Guideline & Manual - Mitigation (Short & long terms) - Action plan - Tactical plan - Policy & Strategic plan
	Coastal & Maritime Resources	High National Maritime Security No Illegal Unreported & Unregulated fishing Fisheries Sustainably	- Ship Detection & Tracking - Maritime Transportation Management - Fishing Zone Management - Coastal Erosion Management - Marine Pollution Management	Strategic Tactical Operational Decision Making Levels

Fig. 4 Integrated in TOP Solution Priorities Platform required

Once the THEOS-2 is launched in orbit, strategic implementation can be taken effectively.

1.3 Required Approach and Methodology from Proposal

The bidder shall propose approaches, methodology and models for achieving sustainable development goals (SDGs) based on the given circumstances and priorities over nine selected river basins namely, Ping, Wang, Yom, Nan, Chao Phraya, Pasak, Thachin, Prachinburi and Bang Pakong. These are given in Fig. 4 , Fig. 5 and Fig. 6.

The proposal shall include data services, models, Geo-Informatics applications utilization, Geo-Informatics products and End-to-End solutions conforming to the demands of Thailand. Each application shall comprise of the following aspects at the minimum:

- Review of related policies, legal frameworks, etc. on social, economic and environmental aspects
- Concepts of working design, process and mechanism for cooperative working with existing systems of GISTDA and stakeholders
- Knowledge and understanding on the current data status of main agencies, includes an approach for integration and information exchange between agencies
- Concepts of data system for management at different administration scales, e.g. national, regional, provincial, local, specific areas, etc. and how all these multiple scale data may be linked, harmonized and administered
- Identify geo-spatial and non-spatial data needed for planning and management in terms of temporal and spatial scales

Instructions to Bidders

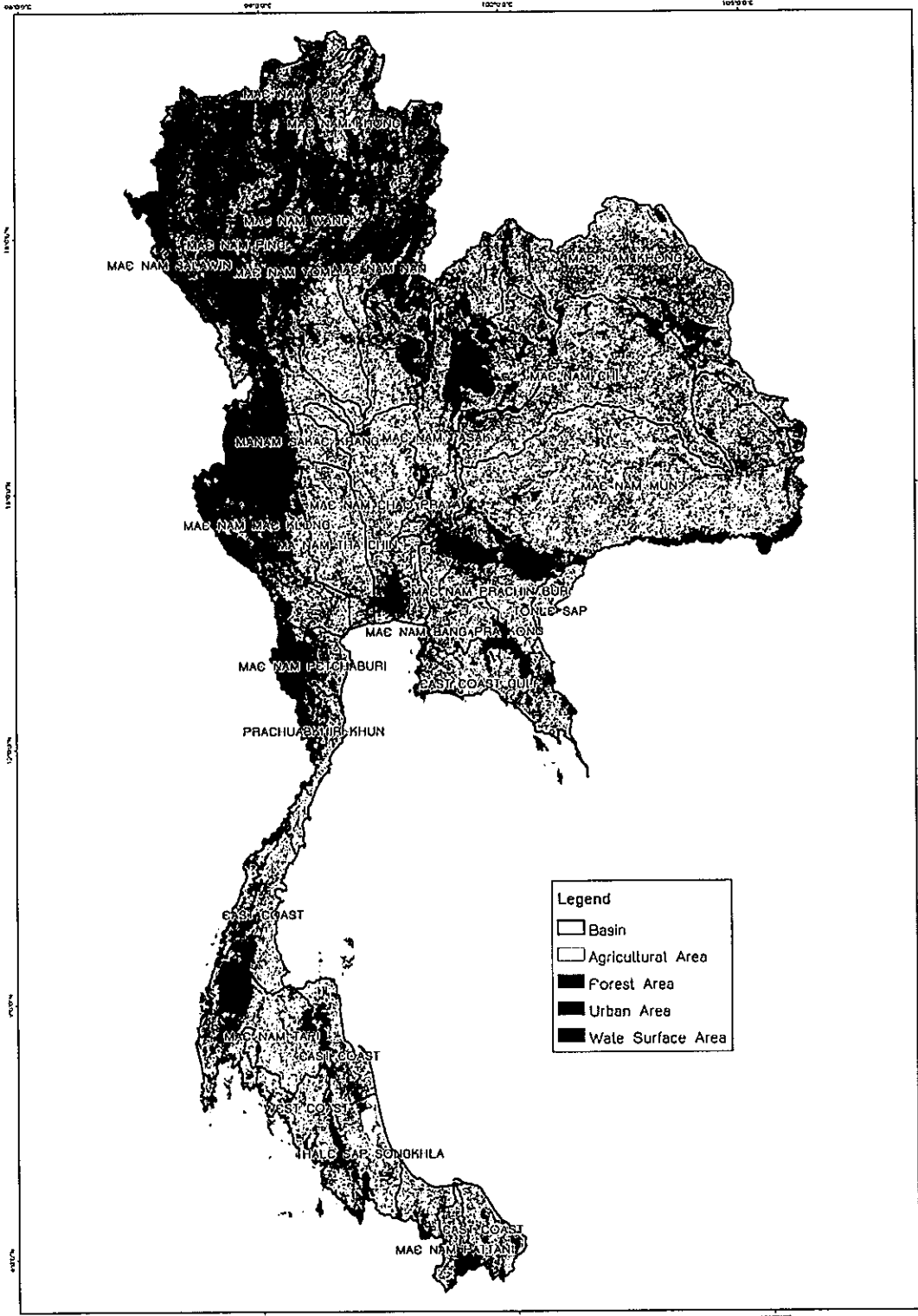


Fig. 5 Watersheds and land use

Instructions to Bidders

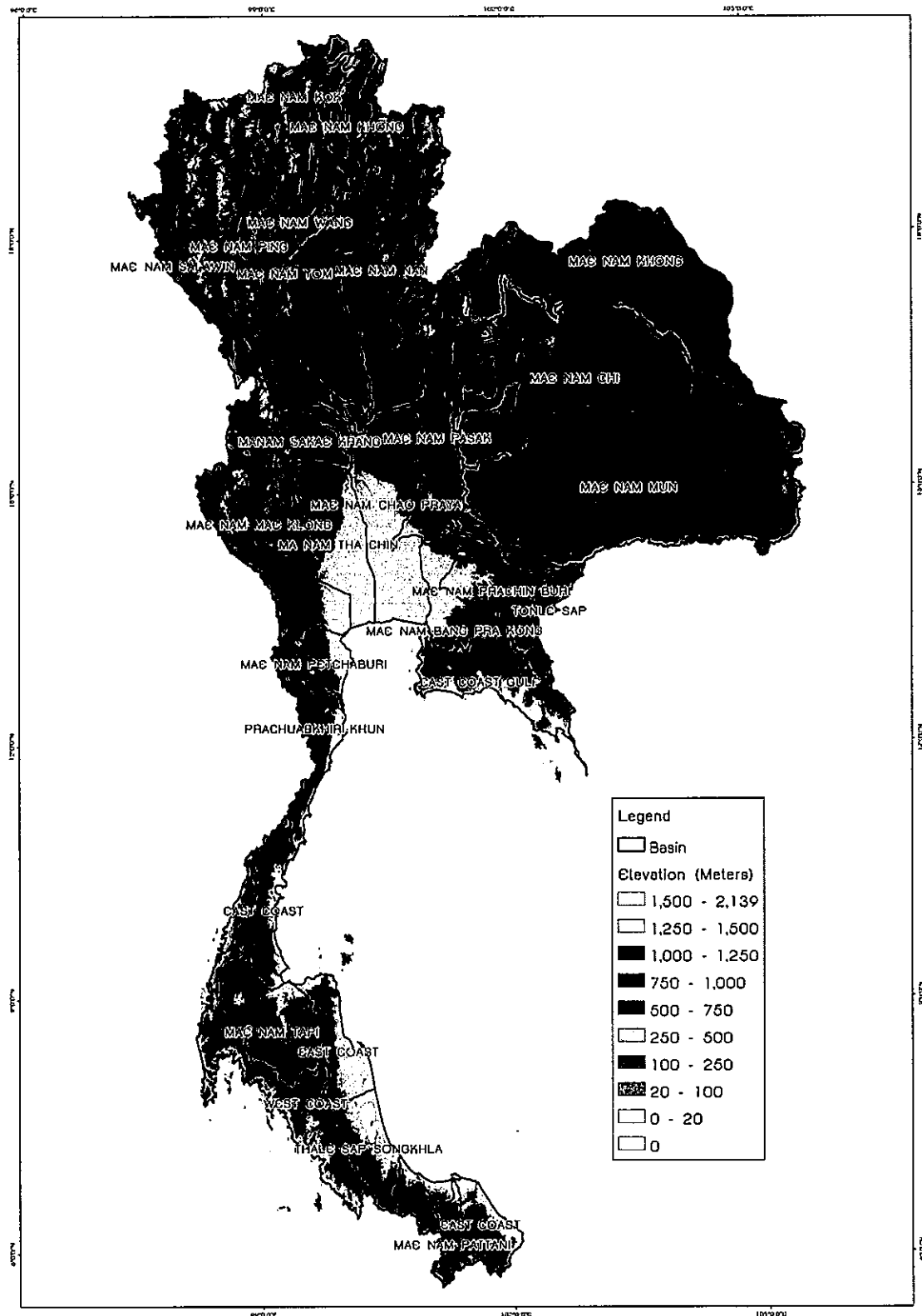


Fig. 6 Watershed Elevation

GISTDA

1.4 Value Measurement Mandates

The selected bidder (successful bidder) shall commit itself to conducting regular and inclusive reviews of progressive changes at sub-national clustered areas (Group of Changwats), and regional levels at the same time of solution design and implementation to identify and create most suitable mechanisms to build on integrated solutions by reviewing and monitoring satellite imageries at these levels. The selected bidder shall develop a list of indicators for measuring and monitoring of the goals and targets and value propositions generated at the national level. Further, the successful bidder (contractor) must take the significance of integrating geospatial and demographic data as the key requirement for the production of a number of measurement indicators.

The indicator framework for impact measurement must be designed to mandate the country to periodically monitor and estimate the proportion of integrated solutions, say, as examples; agricultural land under resilient practices. Collaboration between successful bidder or the so-called contractor is highly expected at the time of implementation to be much conducted at Space Krenovation Park (SKP). The co-creation platform is depicted as in Fig. 7.

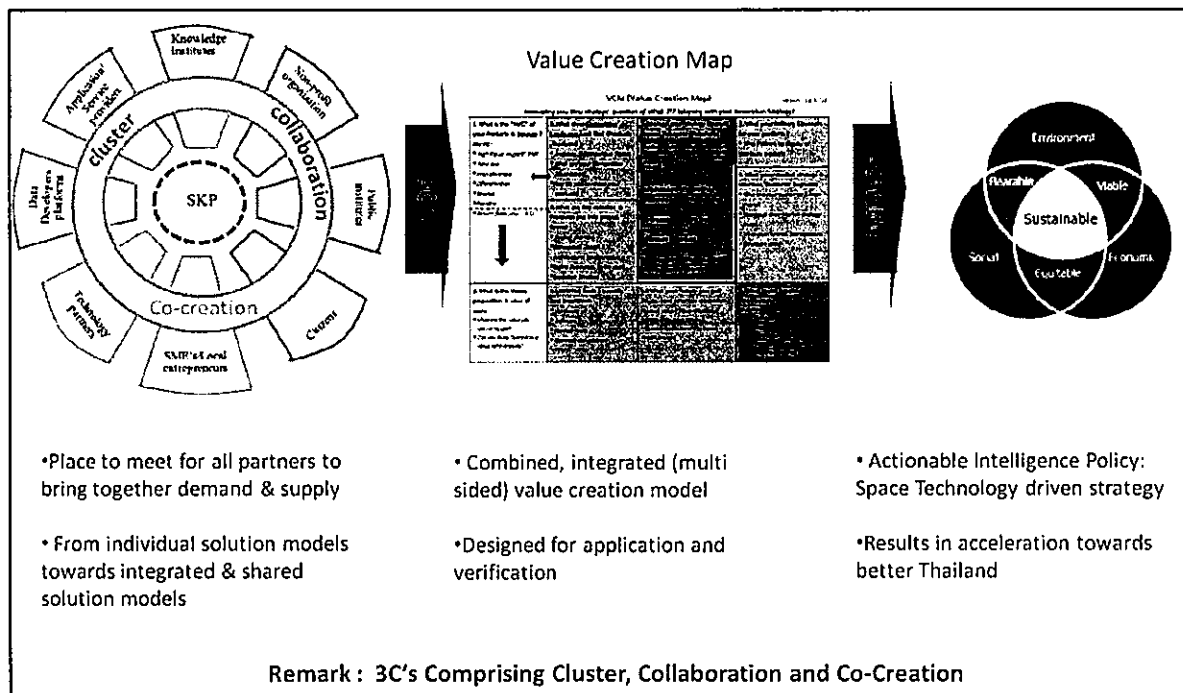


Fig. 7 3C's Platform for Innovation in Space-GIS Technology at SKP

Area based solutions are practically resting upon basic questions like what listed below:

- Where are the farms at what GIS-space technology to increase productivity?
- Where are agricultural yields that diminish due to degradation?

Instructions to Bidders

- Which areas are more prone to natural disasters or to the effects of climate change?

These questions need to be answered to government for the proportioning of agricultural land under productive and sustainable agriculture as the value measurement mandates.

In agriculture, to cite as example, timely and accurate forecasts of agricultural production at national scales using earth observations, including satellite and ground-based observations are required.

The crop monitoring by earth observation and geospatial technology must be designed to support measuring and continuous monitoring to observe land use and land cover changes. Apart from providing a general view of land cover, bidder shall design such solution and put proposal in such a way that the integrated solutions are capable to predict the onset of drought, flooded areas and to best serve as a pre-planning as well as a monitoring and measuring tool.

Mapping resource management, sustainable development, and other societal benefit areas are to be proposed as in TOR to be further described.

Also EO must be enhanced in proposal design for easier and quicker to trace (e.g. oil spills, forest fires etc) and capable to track and allow empirically grounded and analytically rigorous decision making vis-à-vis sustainable development. This must in turn lead to more accountability in the form of Actionable Intelligence Policy (AIP) making and bring to decision making process. Thus, proposal requires

- Creating new solution avenues: encouraging designing new and innovative approaches to EO solution creation including small satellites, drones and crowd-sourcing to facilitate rapid data creation and access in real-time.
- Mainstreaming EO: Earth observation technology and analyses must be proposed for various sectors herein specified to contribute to sustainable development, including agriculture, climate change, disaster management and monitoring urban change. The proposal needs now is to mandate and mainstream the use of GIS-earth observation solutions and decision making tools across the policy continuum.
- Integrative Approach: collaborative approaches in the proposal is encouraged to link different data – demographic, earth observations, environmental and other societal geospatial data together with those in common.
- Imagery, especially spatio-temporal image at high 3D resolution, is the basis for evidence-based decision-making, monitoring and is crucial to the success of the 2030 sustainable goal agenda. The proposer or bidder shall design location and geography

to link to many, if not all, elements of SDGs. Push the 'geospatial value proposition' envelope to the governments and decision-makers at every level.

2 Overall Integration Context: The Requirement for All Approach and Methodology

2.1 Strategic Context

As a technology dedicated to earth information gathering, space technology and geospatial technology systems are valued for providing solutions for planning, execution, and monitoring of any activity that affects the planet earth; be it the land, water and air.

There are needs to move away from data-centric approach to applications that are innovative and result in the realization of 'value delivery'. Such innovation must be taken as challenges and fully realized in the proposals, as is realized by government and also by industry and public at large. Applications arise from needs, and are recognized through goal setting and strategies for the creation of value-added services will be accessed and measured by policy evaluation directly. Implementing this project direction must extend to all areas of solutions as well. New technologies evolve like UAVs which can provide near real-time must be proposed for monitoring events to move solution up to new level of intelligence.

Note also that the space technology and geospatial ecosystem will be required to go beyond static building blocks like GIS, GPS, image processing and imagery to go right into daily dynamic living. The key requirement is then an integrated approach that addresses the needs of area based solution domains which will incorporate those future technology growth.

The proposal is then required to put together whatever is necessary to realize these needs to make realize the full potential of space geospatial technology, the whole (holistic) is much bigger than the sum of its parts is the integration context required in TOR response.

3 Innovative Singularity Platform for Area Based - Solution System Integration

3.1 System Integration and Integrated Solutions: The Design and Implementation Focused

As we find our experiences to reject systems that create silos, specific, individual or forced inefficient work- flows, system integration is the key to making disparate solutions fit the events workflow rather than the other way around. Any key design and implementation in any ecosystem in this TOR are meant to focus on integration of Satellite Solution System (SSS).

Hence; the re-emphasis points are;

- Total integrated solutions types of dense clusters of such solutions to be herein

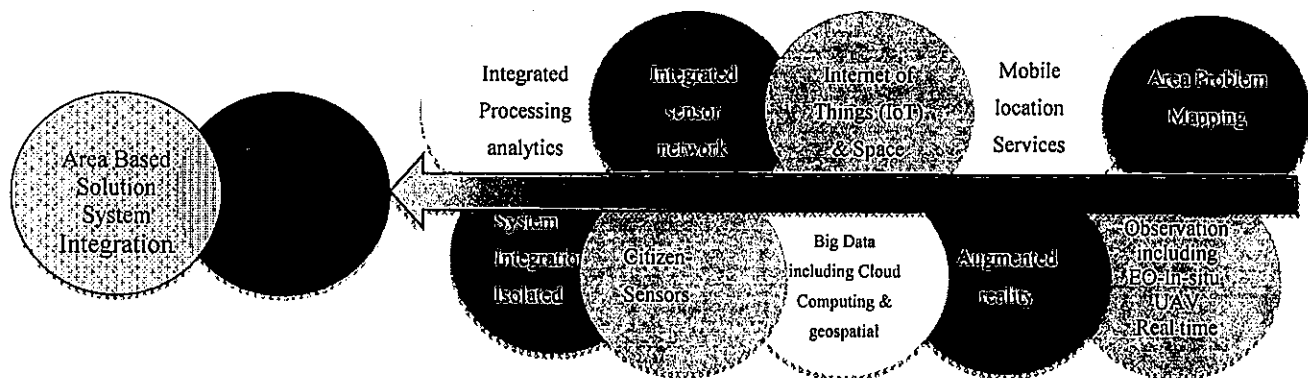
GISTDA

described are to be proposed, instead of isolated ones acting it in bits and pieces as commonly found.

- Total integrated solutions in the mode of solution system integration must be designed towards management and AIP purposes.

3.2 The Requirement for all Approach and Methodology

- Space-Geospatial Technology must be moved to providing total solutions in vertical way, connecting environment to unify projects across horizontal value chains.
- Solutions must open up a whole new level of co-creation across GISTDA and government agencies and public as well as social enterprises, up to decision making at government level. This diagram below serves also as descriptive elaboration of Fig. 2 and Fig. 3.



Innovative Singularity Platform for information Integration; Fusion of Solution System Integration:
(an elaboration of Fig. 2 and Fig. 3)

3.3 The Internet of Things

Fig. 2 and Fig. 3 are best understood by further elaborations. Note that smart devices are required to act as intelligent systems equipped with functions for geo-localization, visualization, simulation and anticipation. These must be designed to act with algorithms and databases that are to be fed and accessed via cloud-services on the Internet, basically anytime anywhere.

3.4 IOS (Internet of Space) - Enablement

With reference to Fig. 2 and Fig. 3; it is noted that global navigation satellite systems in combination with smart devices must be designed to provide data, also collected by mobile phone citizens, through visual recognition. In areas such as local land-use planning in various incidents in Changwats, as well as regional economic development, there are also calls for data to be attached or linked to such attributes as river, side buildings, infrastructure and land. Temporal

(4D) data for those attributes-type is also regarded as an integral part of the land-water system, and they must be incorporated in the design.

3D Laser Scanner with the processing power to execute all of these processes, in near-real-time is needed to produce geo-referenced point clouds when considering overall productivity.

3.5 Data Fusion and Smart Phone-Citizen Sensors: Mission critical GI Application design.

The proposals must recognize technological advances brought about by satellite imaging, satellite based positioning and rapid proliferation of digital and computing technologies. As listed in Fig. 2 and 3 in mapping processes, any modernized and automated surveying – from ground and aerial (both manned and unmanned) platforms must be designed to allow measuring/collecting varieties of relevant parameters for advanced digital data analysis, data fusion, data mining and data analytics to be able to crunch volumes of GI (Geo-Intelligence) real-time and expected to generate new perspectives of society or human activities in geographical domain in intelligent ways.

At the same time, large scale hardware implementations (e.g. cloud computing) and smart phones to be more and more advanced and ever now regarded as citizen sensors due to embedded GPS chips, must be designed to bring to the reach of GI solutions to every citizen's hands: "mission-critical GI applications"

3.6 Actionable Intelligence Policy (AIP)

The Fig. 2 puts realization of EOS and GI to impact upon tremendous societal relevance and placing demand on Governance – every action of governments will seek questions and solutions from within and from outside – to cite mixed cases as examples, what the crop zoning; why the forests burnt away; why water in a flooded area is staying rotten, how economic zones are located/sanctioned; how watersheds must be developed; how a ring-road around a city must be aligned; how economic corridors are of land use optimized; how urban and related activity such as traffic can best be intelligently managed; how pollution of industries are dissipating; which are best areas for utility plants are topical questions require AIP in convergence decision making.

The proposal must then recognize that the government is to use EOS-GI for making policy, inventory/mapping of natural and man-made resources, improve zoning and gain benefits of development, improve equity in decision making and managing disasters; and in many national development and regional collaboration activities (ASEAN).

GI STDA

The proposal must design to incline to more and more upon EOS-GI future capability for supporting governance activities, help prepare sustainable development strategies, involve citizens in participatory democracy, enable enterprises to manage business better and bring space-geographical innovation to citizens. Thus, the proposal is required to enhance EOS-GI as the main form Actionable Intelligence Policy (AIP) to governance for development of society and citizen activities.

The design and implementation must create the impact EOS-GI “Spatial Analytics” - as key domain for “Solution Intelligence” (including governance intelligence, citizen-intelligence, society-intelligence, commercial intelligence, security intelligence) and bringing more “innovation and wisdom” to humanity; particularly for governments to act more responsibly in governance with solutions of “multi-layered disparity”

3.7 Intelligent: An Ultimate Requirement

- To be intelligent as required and above described is the ability to propose to use space technology and geospatial information intelligently.
- The proposal must consider fusion of networks, space, geospatial technologies, IoT, Big Data and Cloud as the tools that will enable such intelligent solution.
- Another tool is the 3D that integrated data with geospatial context at various levels of details from simple extrusion to detail.
- Hi-resolution imagery and 3D models to create a data base of potential sensitive areas such as plan flood measures, in advance of major event and to evolve rapid action plans if and when an incident, like flood occurs. However geo-intelligence involves much more than maps. It also involves transaction data, sensors and intelligence from social media network which can help to make policy intelligently.

Such requirement must induce government to make democratically-conducive development plans; prepare the nation for better internal security; help manage borders of nation and bring many other management. With vast amount of EOS and GI that are to be available, coupled with necessity for EOS-GI based governance, the bidder(s) are challenged to fusion analytics of the EOS-GI world to have proposals to bring new and innovative solutions and knowledge to government citizens, society, and the world at large. This new spatial analytics innovation is required to trigger a new meaning to our actions (as citizens, society and nation) – thereby, defining what we call AIP-DMS (Decision Making System).

Instructions to Bidders

And; this AIP will then be required to provide the means to create, manage, understand and act upon a constant flow of integrated solution in an interactive environment that drives smarter decisions and decisive action. Hence the proposal is expected to go beyond traditional geographic information systems. The approach must be "Dynamic GIS". This means superior data high resolution, high accuracies and frequent updates, leading to real-time data for actionable intelligence. This continuous flow of new integrated solutions must be made possible by fusing the real and digital world's together, delivering values with accurate digital depictions (3D models, scans, photos, maps) of problem reality over areas of interest in Thailand; turning solutions into Actionable Intelligence Policy (AIP). This is an absolute necessity for the proposal implementation to make Thailand to keep up with the pace of change and meet the challenges of a growing world.

The logo for GISTDA (Geospatial Information Science and Technology Development Agency of Thailand) is located at the bottom center of the page. It features the word "GISTDA" in a stylized, italicized font with a small globe icon integrated into the letter "I".

APPENDIX 3: REQUIREMENTS FOR SOLUTIONS AND APPLICATIONS

1 Overview of Integrated Solution Requirement and Target Areas

One of major problems of Thailand recently is natural disaster. As mentioned on the Fig. 8, starting from the center, such as W (Water), we all know that water is led to lots of major problems in Thailand, such as Flood, Drought, Landslide & erosion. By using remote sensing technology, rainfall distribution, Runoff, Flood area, water depth and DEM would be developed products as mapping, measurement, monitoring and modeling. However, individual flood area map, water depth or DEM is unable to deliver the efficient solutions. Therefore, the integrating of those products would be greater solutions for management level to solve the disaster problem more efficiently. For example, Flood drainage and control would be developed from flood area, water depth and DEM. The people would be evacuated before disaster occurred. The damage assessment and compensation would be reliable and cost effective for the country. The management level or decision makers could play a significant role to prepare, prevent, rescue and recovery for better life of the Thai nation. In order to make a sustainable development plan, the above integrated solutions would be developed to an actionable intelligence policy for a policy maker level. The action, tactical and strategic plan, such as flood way, irrigation construction, setting legislation issues etc. would be created for short and long term development to overcome the problem sustainability.

For Fig. 8 as an example of interested applications for each subject or discipline, the bidders could study more on the Annex as attached for the government policy, the 20-year National strategic plan (2017-2037) and the twelfth National Economic and Social Development Plan. The bidders could propose other applications or solutions than mentioned diagram if it is necessary to develop or leverage Thailand more.

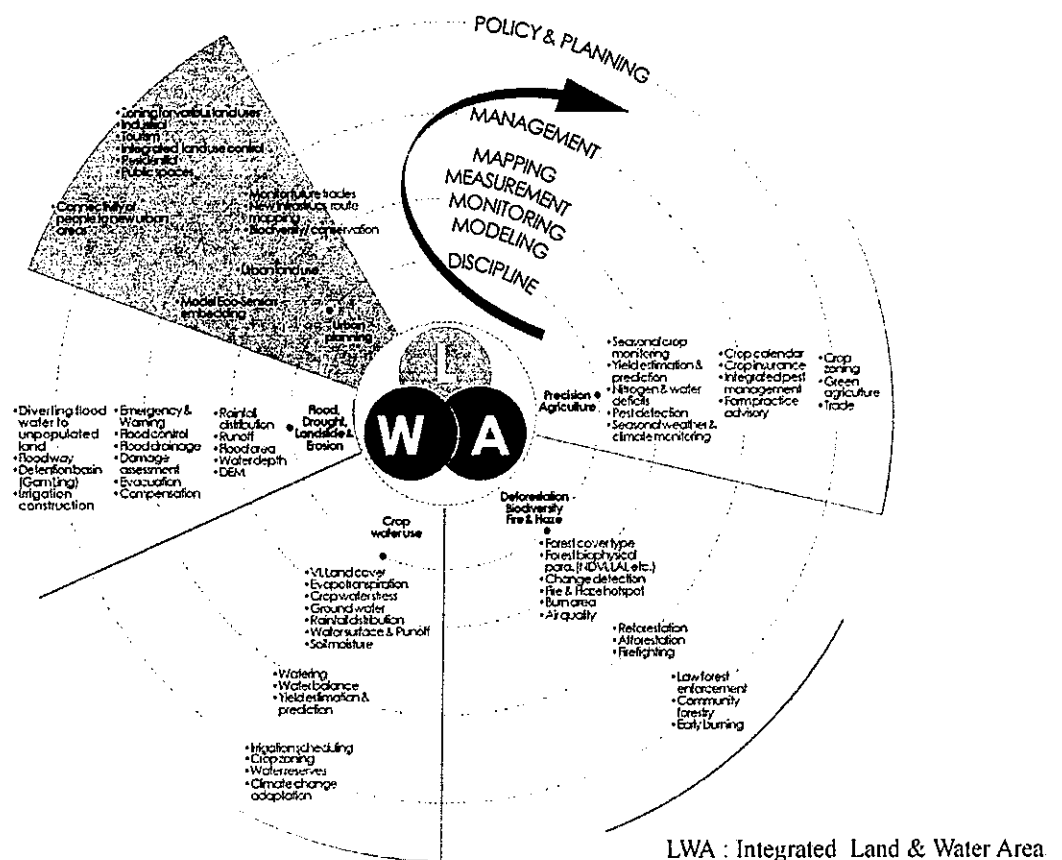


Fig. 8 Conceptual Framework of Integrated Solutions

Integrated Land - Water Resources Management (ILWRM) at River Basin Level

- For the Integrated Land - Water Resources Management (ILWRM) at River Basin Level is of essence being required in this term of reference (TOR) as an approach for an integration of the activities; basically carried out by individual government water sectors, acting in their own interests, with very little interaction with one another in the solutions. This TOR requires to make a river basin approach in the proposal in the implementation to serve as a comprehensive basis for managing water, land use and land cover resources more sustainably and will thus need to lead to policy to social, economic, and environmental benefits in integral context.

- To get started with ILWRM, bidders are required to identify the full spectrum of problems and government stakeholders and local involved in river basin areas as well as to go on site to have a good understanding of how other business and production sectors are related to water and how they relate to every activity. Bidders are meant to propose to design a living

Platform using images interactively with project team proposed, together with proposals on methodology with new innovative solutions.

- The integrated solutions ultimately targeting policy-makers, drawn at river basin level and the need to promote it at the policy level; and must incorporate the evolving and dynamic nature of the Land - Water and people process as shown in Fig. 3.

- Since Land and Water are fundamental for sustainable development, it affects inter alia health, poverty alleviation, disaster reduction, and ecosystem conservation, and cuts across all UN 17 sustainable Development Goals. Implementing ILWRM at the river basin Level is therefore an essential element in managing integrated land-water resources more sustainably to lead to long-term social, economic and environmental benefits. The recognition of ecosystem requirements, and the risk of declining water availability due to climate change in order to achieve water security is a central requirement of the proposal along with managing risks while responding to, mitigating disasters, The path towards water security requires resolving tradeoffs to maintain a proper balance between meeting various water consumptive needs, and establishing adaptable governance mechanisms to cope with evolving environmental, economic and social circumstances.

- GIS-Space Technology Platform must be proposed to execute as “a process that promotes the coordinated development and the management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner with the sustainability of ecosystems. The nine river basins (Ping, Wang, Yom, Nan, Chao Phraya, Pasak, Thachin, Prachinburi and Bang Pakong) are to be taken to form the basis of design requirement at the time of the satellite construction, prior to launching. A focus on allocating and delivering reliable water-dependent services in an equitable manner. It is a holistic approach we that seeks to ensure integration of the management of the physical environment within that of the broader socio-economic and policy framework.

- Benefits of GIS-Space Technology approach to integrated water resources management at the river basin level.

- Perspectives (shown in Fig. 3 and Fig. 4) should enable integration of downstream and upstream issues, quantity and quality, surface water and land use and water resources provide in a practical manner. By responding to changing social, economic and environmental needs or

impacts. The Platform to be proposed must be dynamically responsive to sustainable water resources management by mapping, monitoring, modeling, measuring and managing water resources in the basin, (see also Fig. 2 and Fig. 3) building a more integrated institutional framework, or improving environmental sustainability. The platform in each respective proposal issues must enable the dynamic and evolving process outside and within the basin.

- The management of water-related disasters such as floods and droughts, including appropriate risk management, has to be designed and proposed as an essential part of the proposal.

- Agriculture, Food security, Environment, Industry and many other elements are closely related to water resources management. Therefore, the importance of water resources for the development and management at the basin level is recognized at the highest national, regional, and local levels.

- A foundation towards adaptation to climate change must also be perceived as the fundamental water challenge in the region, and such change must include increases in the number and severity of floods and droughts over seasonal patterns and ultimately determine when, where, and how much water is available due to climate change with direct impacts on the basin. Therefore, the proposal at the river basin level is the foundation upon which the implementation of adaptation strategies, based on a sequence of climate change projections and impact assessments, must be realized. The Space-GIS platform must provide useful insights into the interaction of various sectors on climate change processes.

- The platform given (Fig. 2) is a conceptualization of the process, interactive, iterative, evolutionary, and adaptive process, adjusting to new needs, circumstances, and solution goals. The evolutionary concept is only to adopt any progressive space technology and GIS.

- It requires cooperation sensor fusion and integration.

- It requires the pursuit of better solutions that adopt space technology and GIS to adapt to changing circumstances and values.

- Land and Water resource systems are integrally, directly and indirectly affected by the interaction of numerous human related drivers of economic, social, and demographic functions, including climate change as an uncertain driver.

Instructions to Bidders

- Designing solution framework is required as a platform for adapting to technology changes where the adaptation responses to those solution changes can be prioritized.
- Address special drivers such as climate, land-use changes, and the agricultural footprint in the evolving geo-dynamics process.
- Basin management plan and clear vision.

Water resources development integrated over various sectors and users is facilitated by the preparation of a master plan that reflects the individual sector plans and offers the most effective and efficient utilization of the resource.

- Water allocation plans.

Preparing a master plan that reflects individual sector plans facilitates the coordination among various sectors and advocates the most appropriate utilization of a basin's resource.

- Good knowledge of the natural resources present in the basin.

Adequate knowledge and information on the water resources inventory and human resources of the basin is desirable. Including scientists as water resource managers can help maintain and accrue sound knowledge of the natural resources.

- Comprehensive satellite monitoring and evaluation measure.

Monitoring and evaluation measures are required for ensuring that the outcomes are properly implemented, and to identify the needs for adjusting solution management strategies. Upgrading new Space-GIS technologies are to be required across the contract period for effective performance both of local and central Government in Land management.

Water sectors and their related interests

- Agricultural sector-primary concern is food production, water is an instrument.
- Water for agricultural production

Water, together with land, is an instrument for agricultural production. The production outputs are food and ultimately revenues for the farmers. For farmers, water is a means of ensuring their livelihood on their land. This cannot be realized without securing the water necessary for agriculture. The agricultural sector is also strongly influenced by national policies.

2 Geographical Coverage

The coverage of the integrated solution platform development shall include any of the area within the zone specified in Fig. 9.

Minor adjustment to this ROI can be made before contract start by mutual agreement, and subject to a feasibility assessment.

The Region of Interest: The river basins of Ping, Wang, Yom, Nan, Chao Phaya, Pasak, Thachin, Prachinburi and Bang Pakong and Gulf of Thailand

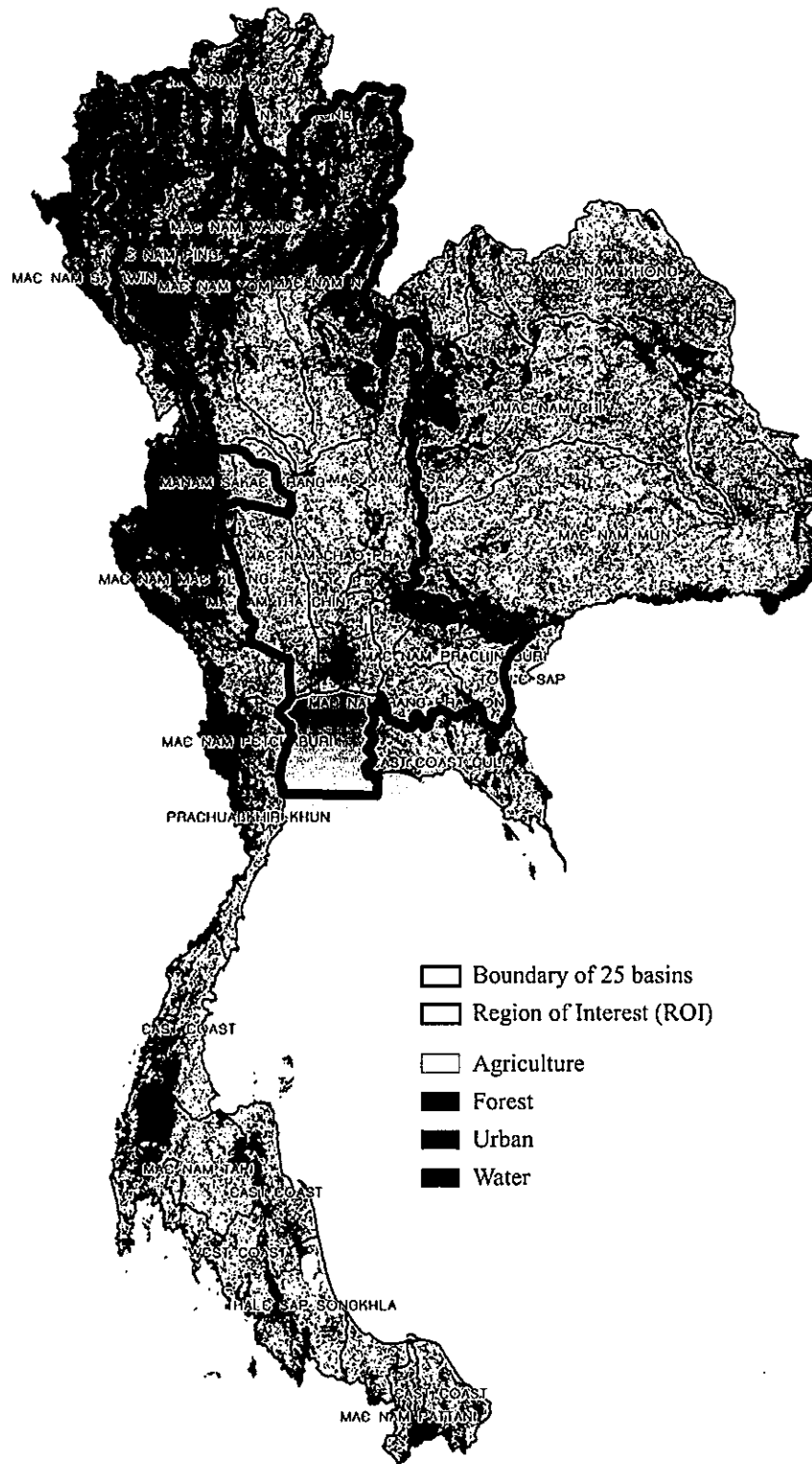


Fig. 9 Region of Interest (ROI) available to the Solution Development

Remark : ROI here is for explicit 5 solutions which explained in Heading 7.1 to 7.5, whereas ROI for the 6th solution following Heading 7.6 is shown in Figure 11 and 12.

3 Conceptual Architecture

Bidders shall note that the strategic intent of the architecture of the THEOS-2 system is a conceptual architecture utilizing the data sources as described in the platform Fig. 2 and contain processing or applications facilities at provincial, local or even at regional levels in other ASEAN countries.

It is for the bidder to define design and propose the overall system architecture and networking needs.

Specific attention should be given in the applications area to devices, products and applications that enable the data to be utilized by the end-solutions at the operation level up to AIP.

4 Solution Segment Developments

The solution facility segments will be iterated with the solutions based on suggested implementations from the bidders

- Bidders are invited to propose solution facility implementations and applications and products for specific areas of solution needs.
- The bidder shall specify a development plan with costing including
 - Design and solution iteration
 - Hardware/software implementation
 - Existing GISTDA applications and products and customization needed
 - Resourcing such as professionals
 - Implementation plan including installation, verification, support and training
- The SKP shall serve as the base for the solution facility design and development and the bidder shall define how the resourcing in Thailand shall be performed and the level of personnel from the bidder company to be based in Thailand

5 Applications and Products Architecture

The bidder shall maximize the commonality of applications and products architecture and development in order to limit replication, duplication and inconsistency.

All applications and products should be developed to recognized open standards (i.e. Open Geospatial Consortium (OGC) standards) in order to allow interoperability.

6 Core Product Requirements

The provision of the core imaging products is central to the THEOS-2 program. Thailand has needs for mapping at various levels of resolution in order to service the needs of the agencies, institutions and commercial entities in the country.

The main agency with responsibility for mapping and cadastre is the Royal Thai Survey Department (RTSD).

One of the differences between Thailand and other countries is the baseline ordnance ratio used for local land mapping and registry. In Thailand this is 1:4000 as this corresponds to the national measurement system. Other ratios are used extensively in mapping for sub-district, provincial and national purposes.

Ratio	Usage
1:4000	National baseline system for land registry
1:10000, 1:25000	Urban and infrastructure mapping
1:50000, 1:100000	District and provincial mapping
1:250000	Full-country atlas

- A detailed mapping of urban areas and areas designated for rapid change shall be taken at 1:10,000 survey ratio or better – the bidder to stipulate the best frequency of update possible
- Provision of higher resolution mapping (1:4000) shall be assessed by the bidder
- A “cloud-free” application using mosaicking or other algorithms shall be part of an automated processing system
- Automated systems for combining datasets of the same location (i.e. optical and radar), shall be included in the system
- Temporal imaging of a set location (4D mapping) shall be included in the system
- Area of interest selection shall be performed using a “Google earth” type interface or other solution-friendly interfaces

In addition to imaging, the core products shall include elevation modeling which is used extensively in Thailand as input to various applications products and services. A pilot project for accurate elevation measurement has been ongoing using LiDAR technology embarked on an aerial survey plane.

- A full country base elevation model shall be produced using high resolution data for input to change detection, flood hazard mapping etc.
- An optimized mix of satellite (InSAR, Stereo mapping), aerial (LiDAR) and other data sources may be used.
- Existing data, such as LiDAR elevation modeling for the central Thailand region, shall be incorporated

7 Explicit Solution Specification Requirements in ITB

7.1 Agricultural & Food Security

The agricultural sector is one of the most important sectors for Thailand, for both national food security and as a major export element of the economy with around 320 million hectares of arable land and approximately 29 million people directly or indirectly employed as part of agricultural activities.

Applications and products which can increase the yields and quality of crops in Thailand have a direct effect on the national GDP and export growth.

The agricultural sector is also a major commercial sector in Thailand with stakeholders needing access to forecasting on supply and pricing including food processing companies, seed companies, agricultural insurers, crop traders, cooperatives, individual farmers and landholders.

For the agriculture, integrated solutions shall be developed to support crop across the whole of Thailand and Southeast Asia (SEA).

- The bidder shall propose a system architecture covering:
 - the end-to-end system from satellite imagery
 - the central system administration under the authority of GISTDA and/or Ministry of Agriculture and Cooperatives (MOAC)
 - the solution facilities and installations at the local government offices

Instructions to Bidders

- the applications and solutions used by individual users and/or on a village basis.
- The bidder shall propose the architectural design of the solution facilities and installations for the GISTDA and/or MOAC and/or the local government offices including hardware, software and any third party products.
- The solution facilities and installations for the GISTDA and/or MOAC and/or the local government offices shall be co-developed at the Space Krenovation Park (SKP) in the first instance to allow end-to-end verification and solution training before deployment and installation at the target sites.
- The satellite data used may include multispectral, hyperspectral, radar or other data as necessary according to the bidder design, but for any data not available from existing sources (THEOS-2 proposed sources or existing GISTDA downlinks from third party satellites), then the cost and implementation of extra downlinks, data purchase or other costs shall be detailed.

Minimum requirement in relation to satellite imagery

Duties	Type of technology							Frequency of information				Data volume
	Optical			Radar								
	VHR	HMR	MLR	X	C	S	L	D/AH	W	M	Y	
Analyze cultivating area		X		X	X	X	X		X			D
Land use		X	X		X	X	X			X		D
Soil survey					X	X	X				X	D
Pest control and management		X						X				D
Determine agricultural area			X		X						X	DD
Agriculture database	X	X			X					X		D
Compensation	X							X				D
Crop production forecast		X	X	X	X	X	X		X	X		DDD

- The dataset shall include meteorological data and additional data to enable forecasting and modeling, then the cost and implementation of extra downlinks, data purchase or other costs shall be detailed.
- The bidder shall identify other data sources (aerial, in-situ or other), that are necessary to supplement the satellite data, with an estimation of data collection frequency and availability.
- The revisit times for data acquisition shall be specified by the bidder with a justification against the crop season and shall be sufficiently frequent to allow estimation of crop growth, maturity and condition.



Instructions to Bidders

- The bidder shall propose a minimum of 13 crops to be differentiated (Rice, Cassava, Oil Palm, Rubber, Sugarcane, Maize, Pineapple, Lychee, Rambutan, Durian, Mangosteen, Coconut and Coffee), plus Napier Grass for energy generation.
- The deliverables for solution facilities and installations shall provide the following:

Minimum requirement for solution deliverables

	Scale	Frequency of information						Coverage	Remark
		R	AH	D	W	M	Y		
Agricultural mapping, measuring and monitoring:									
• Crop classification						X		Country	OA > 85%
o 13 major crops	1:50,000							SEA	
o rice, sugar cane, maize, cassava, oil palm, para rubber	1:250,000						X		
	1:4,000						X	Country	OA > 85%
• Crop growth & condition	1:50,000				X			Country	
• Crop stress (e.g. water, nitrogen, etc.)	1:50,000				X			Country	
• Crop disease & pest	1:50,000		X					AOI	
• Soil moisture	1:50,000			X				Country	
Agricultural modeling:									
• Yield estimation	1:50,000					X		Country	
• Crop calendar	1:50,000					X		Country	
• Crop water use	1:50,000				X			Country	
• Crop disease spread	1:50,000		X					AOI	
Agricultural management:									
• Crop zoning	Variance						X	Country	
• Crop damage (e.g. flood, drought, disease, pest, etc.) by volume and value	Variance		X					AOI	
• Crop insurance	1:4,000		X					AOI	

- The solution for individual users or village levels shall be user friendly (e.g. Thai-language, intuitive, interactive), shall be made available on mobile platforms (e.g. web, handheld, mobile phone, tablet) and shall provide:
 - Information on crop pricing, commodity levels
 - Alerts on crop pests, hazards and other information
 - Meteorological forecast information including rainfall predictions, temperature predictions and humidity levels
 - Soil moisture estimations

- Crop stress estimations (e.g. water and nitrogen)
- A feedback mechanism allowing inputs from in-situ data from the solutions

7.2 Integrated Water Management

Integrated Water Management, including managing water related disaster events such as flooding, is one of the prime areas in which satellite data and the THEOS-2 program must be able to provide benefits to the country.

The flooding of 2011 incurred losses of around 800 lives and over \$45 billion in damages to industry, agriculture and private property, and lesser flooding occurs on an annual basis.

Both natural and non-natural factors are relevant for the flooding problem – the high annual rainfall of 1,600mm per year may be concentrated in a short time during the monsoon season (April-October), with the levels of water retention in dams and reservoirs becoming critical. The geography of the country plays a large role in the widespread distribution of flooding events (65 of the 77 national provinces were affected).

Accurate knowledge of topology, such as comprehensive elevation mapping, the reservoir and dam depths for water volume calculations, river basin mapping, silting and dredging activities, and inland water retention and soil moisture content are essential elements in determining flood forecasting, flood hazard mapping and water course planning.

In 2013, Thailand has recently embarked on an ambitious water management program (\$11.7 billion), consisting of 9 modules including new dam and reservoir construction, water course management (river embankments), and a flood forecasting system.

The THEOS-2 program should be used increasingly to support the infrastructure development and monitoring (water levels, subsidence, land compensation etc.) as well as playing a role in delivering data into the forecasting and warning systems.

For the Integrated Water Management, integrated solutions shall be developed to support water management across the whole of Thailand.

- The bidder shall propose a system architecture covering:
 - the end-to-end system from satellite imagery
 - the central system administration under the authority of the GISTDA, the Department of Water Resource (DWR) and/or the Royal Irrigation Department (RID)



Instructions to Bidders

- the solution facilities or installations at the local government offices
- the applications and solutions used by individual users and/or on a village basis.
- The bidder shall propose the architectural design of the solution facilities and installations for the GISTDA, DWR, RID and/or the local government offices including hardware, software and any third party products.
- The solution facilities and installations for the GISTDA, DWR, RID and/or the local government offices shall be co-developed at the Space Krenovation Park (SKP) in the first instance to allow end-to-end verification and solution training before deployment and installation at the target sites.
- The satellite data to be used may include multispectral, hyperspectral, radar or other data as necessary according to the bidder design, but for any data not available from existing sources (THEOS-2 proposed sources or existing GISTDA downlinks from third party satellites), then the cost and implementation of extra downlinks, data purchase or other costs shall be detailed.

Minimum requirement in relation to satellite imagery

Duties	Type of technology							Frequency of information				Data volume
	Optical			Radar								
	VHR	HMR	MLR	X	C	S	L	D/AH	W	M	Y	
Water management		X								X		DD
Flood	X			X	X	X	X	X				D
Water resource development	X									X		D
Analysis to expand irrigation area / improve current irrigation area			X				X					
Monitor security of municipal water system			X							X		

- The dataset shall include meteorological data and additional data to enable forecasting and modeling, then the cost and implementation of extra downlinks, data purchase or other costs shall be detailed.
- The bidder shall include data from the GISTDA operated Coastal Radar installations in the Gulf of Thailand.

Instructions to Bidders

- The bidder may propose additional sources of data – such as storm surge prediction through radio-occultation - which are not currently utilized in Thailand with details of downlinks, cost and availability.
- The bidder shall include topographic details for water storage and retention areas (reservoirs, dams, run-off areas, flood plain areas), in order to estimate water volume and water reserve forecasts. The bidder shall state the means of collection of topographic data, the analysis methodology (color interval etc.) and frequency of data updates.
- The bidder shall include river basin, estuary and river course information (silting, dredging etc.) to calculate river flow estimations
- The bidder shall include elevation modeling and mapping of water and flood hazard areas.
- Data coverage shall be for the whole of Thailand, including feeder river systems from outside of Thailand.
- Prior to satellite launch in orbit, the designed solution must be completed on the pre-selected water sheds.
- The bidder shall identify other data sources (aerial, in-situ or other), that are necessary to supplement the satellite data, with an estimation of data collection frequency and availability.
- The revisit times for data acquisition shall be specified by the bidder with a justification against the nominal water management and mapping, and a more frequent mapping during periods where flooding may be expected or flood damage assessment has to be performed
- The deliverables for solution facilities and installations shall provide the following:

Instructions to Bidders

Minimum requirement for solution deliverables

	Scale	Frequency of information						Coverage	Remark
		R	AH	D	W	M	Y		
Water mapping, measuring and monitoring:									
• Rainfall, temperature and humidity	1:50,000			X				Country	OA > 85% DEM DEM Country AOI Country AOI Country
• Evapotranspiration	1:50,000			X				Country	
• Water surface	1:25,000					X		Country	
• Water level	-			X				AOI	
• Water volume	-					X		AOI	
• Groundwater	1:50,000					X		Country	
• Soil moisture	1:50,000			X				Country	
• Flood area	1:25,000		X					AOI	
• Water quality (e.g. turbidity, algae, salinity intrusion, etc.)	1:50,000				X			Country	
Water modeling:									
• Water use	1:50,000				X			Country	Country Country Country AOI AOI AOI
• Water scarcity (e.g. consumption, agriculture, industry and ecology)	1:50,000				X			Country	
• Flood risk	1:25,000						X	Country	
• Water flow and flood forecast	1:25,000		X					AOI	
• River flow estimation	N/A			X				AOI	
• Flood damage	1:25,000		X					AOI	
Water management:									
• Water balance	1:50,000				X			Country	Country AOI Country
• Watering control	1:4,000				X			AOI	
• Irrigation scheduling	1:25,000				X			Country	

- The solution for individual users or village levels shall be user friendly (e.g. Thai-language, intuitive, interactive), shall be made available on mobile platforms (e.g. web, handheld, mobile phone, tablet) and shall provide:
 - Meteorological forecast information including rainfall predictions, temperature predictions and humidity levels
 - Storm surge and warnings
 - Flood forecast and warning alerts
 - Water usage estimations
 - Watering control
 - Soil moisture estimations
 - Water quality estimations

GISTDA

- A feedback mechanism allowing inputs from in-situ data from the solutions

7.3 Disaster and Geo-Hazard

The Disaster and Geo-Hazard covers a range of specific areas for which separate applications and products, or combined applications and products, could be proposed.

In 2004 the tsunami caused by an earthquake in Indonesia resulted in over 8,000 lives lost and more than \$2.7 billion in damage and losses. Thailand itself is not a major center for earthquake activity, but does experience moderate quakes particularly on the Thailand/Myanmar border areas.

Thailand also has a risk of landslides caused mostly by heavy rainfall, and subsequent risk of flash flooding.

With over 30% of the land mass of Thailand classified as forestry, the issue of forest fire can have a major effect on the national ecology. Forest fires may be caused by natural means, or by deforestation (burning) for agriculture use.

Damage assessment needs baseline images and mapping taken prior to any fire event to be available for comparison against post fire imaging

Thailand frequently experiences drought conditions during the dry season (October-April), affecting agriculture, livestock, water management and forest fire hazards. During 2013 46 provinces, mainly in the North and North-East of the country, were declared drought disaster areas.

Data from the THEOS-2 program must be designed to help in disaster preparedness and planning (identification of vulnerable areas), response management, damage assessment and liability assessment (insurance coverage etc.) in cases involving human activity.

Some applications and products may have commonalities with other areas and so may be developed as a subset or as a part of a larger application area.

For the Disaster and Geo-Hazard, integrated solutions shall be developed to support water management across the whole of Thailand and the areas across borders where disasters may occur and spread into Thailand territory.

- The bidder shall propose a system architecture covering:
 - the end-to-end system from satellite imagery

The logo for GISTDA (Geospatial Information Science and Technology Development Agency of Thailand) is displayed in a stylized, handwritten font.

Instructions to Bidders

- the central system administration under the authority of the GISTDA, Ministry of Natural Resources and Environment (MONRE) and/or National Disaster Warning Center (NDWC)
- the solution facilities or installations at the local government offices
- the applications and products to be used by individual solutions and/or on a village basis.
- The bidder shall propose the architectural design of the solution facilities and installations for the GISTDA, MONRE, NDWC and/or the local government offices including hardware, software and any third party products.
- The solution facilities and installations for the GISTDA, MONRE, NDWC and/or the local government offices shall be co-developed at the Space Krenovation Park (SKP) in the first instance to allow end-to-end verification and solution training before deployment and installation at the target sites.
- The satellite data to be used may include multispectral, hyperspectral, radar or other data as necessary according to the bidder design, but for any data not available from existing sources (THEOS-2 proposed sources or existing GISTDA downlinks from third party satellites), then the cost and implementation of extra downlinks, data purchase or other costs shall be detailed.

Minimum requirement in relation to satellite imagery

Duties	Type of technology							Frequency of information				Data volume
	Optical			Radar								
	VHR	HMR	MLR	X	C	S	L	D/AH	W	M	Y	
Prevention and monitoring landslide	X			X			X	X				D
Prevention and monitoring flood				X	X	X	X	X				D
Prevention and monitoring drought					X		X	X				D
Disaster prevention plan	X							X			X	DD
Monitor emergency situation	X											D
Pollution map	X											D



Instructions to Bidders

- The dataset shall include meteorological data and additional data to enable forecasting and modeling, then the cost and implementation of extra downlinks, data purchase or other costs shall be detailed.
- The bidder shall include air observation (e.g. pressure, temperature, wind speed detection, humidity, etc.). preferably on a 12 hourly basis with coverage at 1:25,000 ratio or better
- The bidder shall include data from Unmanned Aerial Vehicles (UAVs), aerial survey or other means
- The bidder shall propose additional sources of data with details of downlinks, cost and availability.
- The bidder shall include elevation modeling and mapping of areas of interest for flood and landside dynamic modeling
- The bidder shall include risk maps for known disaster areas for immediate availability once a disaster is detected.
- The bidder shall deliver disaster extent maps within 12 hours of a disaster notification and detail optical/radar and resolutions that may be provided.
- The bidder shall deliver post disaster monitoring maps on a daily basis until such time as response is not required.
- Data coverage shall be for the whole of Thailand, but with a focus on landslide and flash flood risk areas.
- The bidder shall identify other data sources (aerial, in-situ or other), that are necessary to supplement the satellite data, with an estimation of data collection frequency and availability.
- The revisit times for data acquisition shall be specified by the bidder with a justification against the nominal disaster management (prevention, preparedness, response and recovery)
- The deliverables for solution facilities and installations shall provide the following:



Instructions to Bidders

Minimum requirement for solution deliverables

	Scale	Frequency of information						Coverage	Remark
		R	AH	D	W	M	Y		
Disaster mapping, measuring and monitoring:									
• Cyclone detection	1:250,000		X					AOI	OA > 85%
• Flood area	1:25,000		X					AOI	
• Landslide detection	1:4,000		X					AOI	
• Land subsidence	1:4,000						X	AOI	
• Wildfire hotspot	1:50,000		X					AOI	OA > 85%
• Burn scar	1:25,000		X					AOI	OA > 85%
• Smoke detection	1:50,000		X					AOI	
• Air quality (i.e. PM10, PM2.5)	1:250,000			X				Country	
Disaster modeling:									
• Flood risk	1:4,000						X	AOI	
• Water flow and Flood forecast	1:4,000		X					AOI	
• Landslide risk	1:4,000						X	AOI	
• Land subsidence forecasting	1:4,000						X	AOI	
• Drought risk	1:50,000						X	AOI	
• Fire risk	1:50,000						X	AOI	
• Fire spread simulation	1:50,000		X					AOI	
• Haze spreading	1:50,000		X					AOI	
Disaster management:									
• Emergency & warning	Variance		X					AOI	
• Search & rescue	Variance		X					AOI	
• Flood control & drainage	Variance		X					AOI	
• Firefighter	Variance		X					AOI	
• Damage assessment	Variance		X					AOI	
• Evacuation	Variance		X					AOI	
• Compensation	Variance		X					AOI	
• Recovery	Variance		X					AOI	

- The solution for individual users or village levels shall be user friendly (e.g. Thai-language, intuitive, interactive), shall be made available on mobile platforms (e.g. web, handheld, mobile phone, tablet) and shall provide:
 - Meteorological forecast information including rainfall predictions, temperature predictions and humidity levels
 - Flash flood, drought, fire, tsunami and other disaster warnings and alerts
 - Flood and drought forecast and affected crops
 - Soil moisture estimations and irrigation water supply
 - Damage estimations by type and value
 - A feedback mechanism allowing inputs from in-situ data from the solutions

7.4 Natural Resources and Ecosystem

The Forestry are a major area of interest for Thailand as over 30% of the country by land mass is devoted to forestry, national parks and areas of natural beauty.

The delineation of forestry and national parks areas is of particular concern where encroachment due to agriculture, resort development or logging has taken place.

In Thailand there are specific laws and regulations regarding development, which include the designation of land on an inclination basis. Topographic and elevation modeling data is therefore also necessary for this area.

For the Forest and Coastal area, integrated solutions shall be developed either as specific applications or as a subset of other applications or products.

- The bidder shall propose a system architecture covering:
 - the end-to-end system from satellite imagery
 - the central system administration under the authority of the GISTDA and/or Ministry of Natural Resources and Environment (MONRE)
 - the solution facilities or installations at the local government offices
 - the applications and products to be used by individual solutions and/or on a village basis.
- The bidder shall propose the architectural design of the solution facilities and installations for the GISTDA and/or MONRE and/or the local government offices including hardware, software and any third party products.
- The solution facilities and installations for the GISTDA and/or MONRE and/or the local government offices shall be co-developed at the Space Krenovation Park (SKP) in the first instance to allow end-to-end verification and solution training before deployment and installation at the target sites.
- The satellite data to be used may include multispectral, hyperspectral, radar or other data as necessary according to the bidder design, but for any data not available from existing sources (THEOS-2 proposed sources or existing GISTDA downlinks from third party satellites), then the cost and implementation of extra downlinks, data purchase or other costs shall be detailed.

Instructions to Bidders

Minimum requirement in relation to satellite imagery

Duties	Type of technology							Frequency of information				Data volume
	Optical			Radar				D/AH	W	M	Y	
	VHR	HMR	MLR	X	C	S	L					
Estimate forestry area			X								X	D
Monitor changes in forest area		X		X	X						X	D
Base map for carbon credit			X		X	X	X					D
Verify land encroachment	Δ			Δ				X				D

- The dataset shall include meteorological data and additional data to enable forecasting and modeling, then the cost and implementation of extra downlinks, data purchase or other costs shall be detailed.
- The bidder may include data from Unmanned Aerial Vehicles (UAVs), aerial survey or other means
- The bidder shall include data from the GISTDA operated Coastal Radar installations in the Gulf of Thailand.
- The bidder shall identify other data sources (aerial, in-situ or other), that are necessary to supplement the satellite data, with an estimation of data collection frequency and availability.
- The bidder may propose additional sources of data with details of downlinks, cost and availability.
- The revisit times for data acquisition shall be specified by the bidder but for biodiversity and sensitivity mapping the frequency for a whole country map update shall not be less than 6 months
- The deliverables for solution facilities and installations shall provide the following:

Instructions to Bidders

Minimum requirement for solution deliverables

	Scale	Frequency of information						Coverage	Remark
		R	AH	D	W	M	Y		
Forest inventory, mapping, measuring and monitoring:									
• Forest cover type	1:50,000						X	Country	OA > 85%
• Forest biophysical parameters	1:50,000					X		Country	
• Forest change detection	1:50,000						X	Country	
• Deforestation/ Degradation	1:4,000						X	AOI	
• Land encroachment	1:4,000		X					AOI	
• Reversing illegal forest cutting	1:4,000		X					AOI	
• Tree counting	-		X					AOI	
Forest modeling:									
• Biodiversity	1:50,000						X	Country	
• Carbon credit/stock	1:50,000						X	Country	
Forest management:									
• Forest zoning	1:4,000		X					AOI	
• Land tenure	1:4,000		X					AOI	
• Reforestation & afforestation	1:4,000		X					AOI	
Coastal & marine mapping, measuring and monitoring:									
• Biophysical marine characteristics (e.g. chlorophyll-a, temperature, etc.)	1:50,000			X				EEZ	
• Coral bleaching	1:50,000			X				EEZ	
• Plankton bloom	1:50,000			X				EEZ	
• Oil spill detection	1:4,000		X					AOI	
Coastal & marine modeling:									
• Surface movement (e.g. Oil spill)	1:4,000		X					AOI	
Coastal & marine management:									
• Fishing zoning	1:50,000						X	EEZ	

- The solution for individual users or village levels shall be user friendly (e.g. Thai-language, intuitive, interactive), shall be made available on mobile platforms (e.g. web, handheld, mobile phone, tablet) and shall provide:
 - Localized mapping of forestry natural resources
 - Encroachment mapping using historic and new data comparisons
 - A feedback mechanism allowing inputs from in-situ data from the solutions

7.5 Social Wellness and National Security

The social wellness and national security area covers applications and products to be used by security services both external (armed forces) and internal (Police etc.).

Security applications can help detect trafficking of drugs, contraband and personnel, monitor the build-up of troops and weaponry, and detect indicators that help to identify security risks and potential threats.

Geo-intelligence is the methodology behind “data-mining” sources of data (satellite, aerial, human intelligence) to detect changes and patterns relevant to security interests. For example – a new route cut through forest areas unrelated to infrastructure development on a border may be an indicator of illegal activity such as drug trafficking.

The trainings of personnel, which are able to interpret the data sources plus advanced algorithms, interfaces and processing, are key elements to geo-intelligence.

Although aerial or ground sources may have advantages in terms of accuracy and resolution, the cross-border nature of the security domain means that satellite data with the ability to look beyond national borders can play a significant role in geo-intelligence data collection.

Due to the nature of the geo-intelligence needs, the dataset required has to have high resolution components and also frequent revisit to be able to detect change patterns.

The dataset and applications and products also have to be integrated with existing security data structures. Due to the classified nature of the data, the geo-intelligence applications may be subject to government-to-government agreement or military cooperation agreements.

The major solution of data in this area will be the Thai armed forces, police and other security related services.

For the social wellness and national security, integrated solutions shall be developed to support geo-intelligence across the whole of Thailand and the areas across borders.

- The bidder shall propose a system architecture covering:
 - the end-to-end system from satellite imagery
 - the central system administration
 - the solution facilities or installations at the local government offices
 - the applications and products to be used by individual solutions and/or on a village basis.

Instructions to Bidders

- The bidder shall propose the architectural design of the solution facilities and installations for the central system and distributed data including hardware, software and any third party products.
- The solution facilities and installations shall be co-developed in Thailand at facilities to be designated by the security services to allow end-to-end verification and solution training before deployment and installation.
- The system architecture shall be dual-usage – specific facilities for military command and control, data acquisition, processing and dissemination shall be included
- Where data provision is from the bidder satellite constellation, or from third-party satellites, the bidder shall detail the tasking authority (commanding capability) to be provided and level of priority.
- The bidder shall detail any constraints on data provision due to national political constraints or regulations such as ITAR (International Trafficking in Arms) or EAR (Export and third party restrictions).
- The bidder shall be responsible for initiating any government-to-government agreements necessary to provide data at higher resolutions than civilian standards.
- The bidder shall describe the levels of protection (encryption, security etc.) for the space and ground segments, archive facilities, processing, dissemination and end-solution access.
- The satellite data to be used may include multispectral, hyperspectral, radar or other data as necessary according to the bidder design, but for any data not available from existing sources (THEOS-2 proposed sources or existing GISTDA downlinks from third party satellites), then the cost and implementation of extra downlinks, data purchase or other costs shall be detailed.

Minimum requirement in relation to satellite imagery

Duties	Type of technology							Frequency of information				Data volume
	Optical			Radar								
	VHR	HMR	MLR	X	C	S	L	D/AH	W	M	Y	
Monitoring and surveillance	X			X				X				DD
Analyze change of area and structures								X	X			D
Defense mission along border	Δ	Δ		Δ	Δ			Δ				D

Instructions to Bidders

Defense mission along coastline	Δ	Δ
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- The bidder shall investigate the provision of thermal imaging capabilities (e.g. MWIR and LWIR) for heat signature identification and classification.
- The bidder shall propose the most appropriate resolution/acquisition frequency for the security needs including all-weather and night capabilities.
- The bidder may include data from Unmanned Aerial Vehicles (UAVs), High Altitude balloon systems (e.g. HALO), aerial survey or other means
- The bidder shall propose additional sources of data with details of downlinks, cost and availability.
- Data coverage shall be for the whole of Thailand national territory plus 200 miles from any Thailand border and EEZ.
- The bidder shall detail the exclusive nature of the data provision, or any constraints imposed due to agreements with neighboring countries or territories.
- The bidder shall identify other data sources (aerial, in-situ or other), that are necessary to supplement the satellite data, with an estimation of data collection frequency and availability.
- The bidder shall investigate data fusion techniques (radar/optical fusion or others) for image enhancement and analysis, multisensory merging, 3d and temporal (4d) data display.
- The bidder shall state how it intends to address the recruitment and training of Thai nationals in respect to national security clearances.
- The deliverables for solution facilities and installations shall provide the following:

ISTDA

Instructions to Bidders

Minimum requirement for solution deliverables

	Scale	Frequency of information						Coverage	Remark
		R	AH	D	W	M	Y		
National security mapping, measuring and monitoring:									
• Territorial border	1:4,000						X	Country	
• Building, infrastructures and installations (e.g. permanent or temporary such as camps etc.)	1:4,000						X	Country	
• Intelligence categorized by location, type of threat and severity	1:4,000		X					AOI	
• Ship detection	1:4,000	X						EEZ	AIS
• Vessel type identification	1:4,000	X						EEZ	AIS
• Ship tracking	1:4,000	X						EEZ	AIS
National security modeling:									
• Illegal activity detection	1:4,000	X						EEZ	AIS
National security management:									
• Maritime transportation	Variance			X				EEZ	
• Human trafficking	Variance		X					EEZ	
Social security mapping, measuring and monitoring:									
• Crime surveillance	1:4,000	X						AOI	CCTV
Social security modeling:									
• Crime risk & forecasting	1:4,000				X			AOI	
• Emerging infectious diseases (EID)	1:4,000		X					AOI	
Social security management:									
• Crime warning	Variance			X				AOI	
• Disease control	Variance			X				AOI	

- The solution for individual users shall be user friendly (e.g. Thai-language, intuitive, interactive), shall be made available on mobile platforms (e.g. web, handheld, mobile phone, tablet) and shall provide:
 - Localized mapping of areas of interest using multi-sensor and multi-temporal datasets
 - Alerts and information displays
 - A feedback mechanism allowing inputs from in-situ data from the solutions

7.6 Urban, Economic Corridor Planning and Infrastructure-Augmented Reality

Thailand has a growing urban density, with over 10 million people in the region of Bangkok, and large cities along the E-W economic corridor also growing; leading to pressure on urban development, industrial development, infrastructure and energy usage.

Instructions to Bidders

The land and urban planning areas require detailed mapping and frequent updates to support land valuations, planning applications, major infrastructure planning and monitoring and mapping of urban density, energy use, roads transport etc.

At the present time Thailand is embarking on two major national infrastructure projects – the water management plan of new dams, reservoirs, water retention areas and waterways, and a high speed rail network of 5 lines (North, North-East, East, South, West). These infrastructure plans will entail relocation and compensation, and this has to be monitored and assessed as well as the ecological impact of the developments.

One of the issues for the land survey is the use of a national Thai measurement system based on the ordnance survey ratio of 1:4000, and this may not be achievable with satellite technology under present data restriction regimes.

Government Objectives: Area based development of Eastern Economic Corridor (EEC) is to be taken by the government to turn the land into an economic hub of south east Asia region. The Corridor is shown in Fig. 10.

4 Key planning questions arise in this case:

1) Where are the optimum places to set up new industrial zones and tourism zones (including ferries zones in marine- tourism relates)

2) Connectivity of industrial zones to infrastructures (There are 27 existing industrial estates in the zone). New mega infrastructures are, namely, double trade, railways, high speed rails, motorways, highways, port expansion (Laem chabang phase 3) and extension of airport (Au ta Pao)

3) Drawing the airport (Au ta pao) into Aeropolis zones

4) Infrastructures and Utilities. Planning of mega in line with environment planning to ensues sustainable development. Along the corridor of 120 km. width by 1,600 km. length covering about 200,000 Sq.km; spreading from Quy Nhon and Vung Tau (Vietnam Coast) via the hub to be in Thailand

Spreading from Quy Nhon and Vung Tau (Vietnam Coast) via the economic hub to be in Thailand (EEC comprising Rayong, Chonburi, Chachaengsao provinves) to Dawei (Myanmar) enclosing 14 provinces (Kanchanaburi, Prachinburi, Nakornpathom, Bangkok Metropolitan, Chacheansao, Sakaew, Chantaburi, Rayong, Nakonnayok, Ayuthaya, Samutsakorn, Sumutsongkram, Phetchaburi)

SISTDA

Those four questions induce 5 more enquires to be responded in this TOR, mainly, how the space technology for industrial, tourism & urban planning can be made sustainably;

- 1) Where should the integrated or mixed used Zones be intensified (to tap unused potentials)
- 2) Where should the integrated zones be intensified (to become sustainable)?
- 3) Which industrial clusters (given 10 types of cluster by government) policy should be embedded, in which location to achieve optimal sustainable management?
- 4) What kind of ecological parameters and measures are required; where and when?
- 5) How much industrial growth-regulator/environment are needed and how much should sustainability be applied; where?

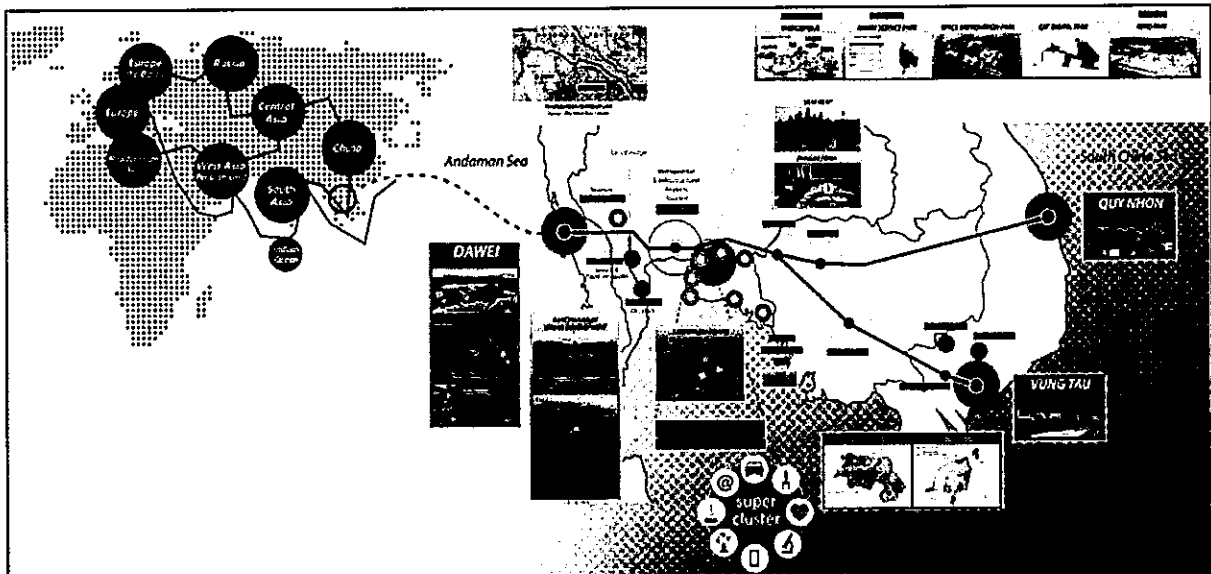


Fig. 10 Economic Corridors connecting from Eastern Seaboard Economic Zone to ASEAN and Beyond

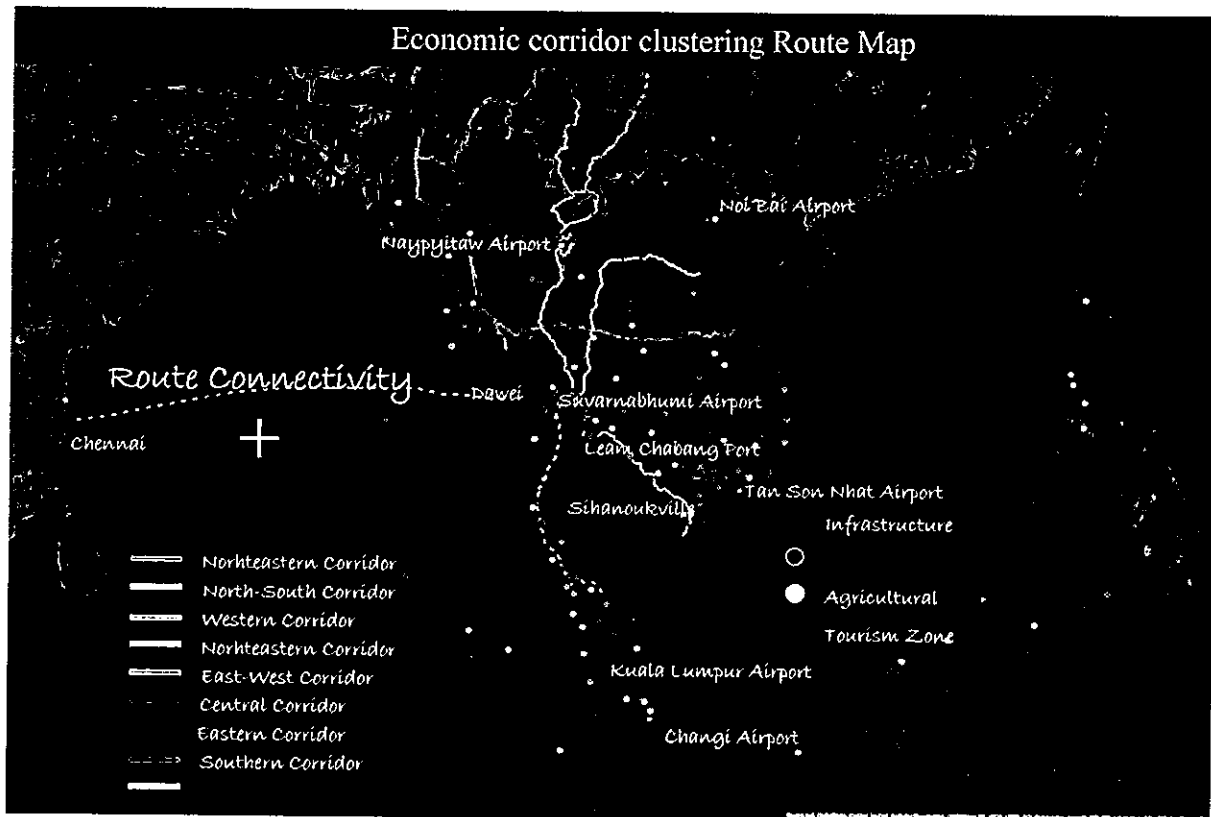


Fig. 11 Economic Corridor Clustering Route Map

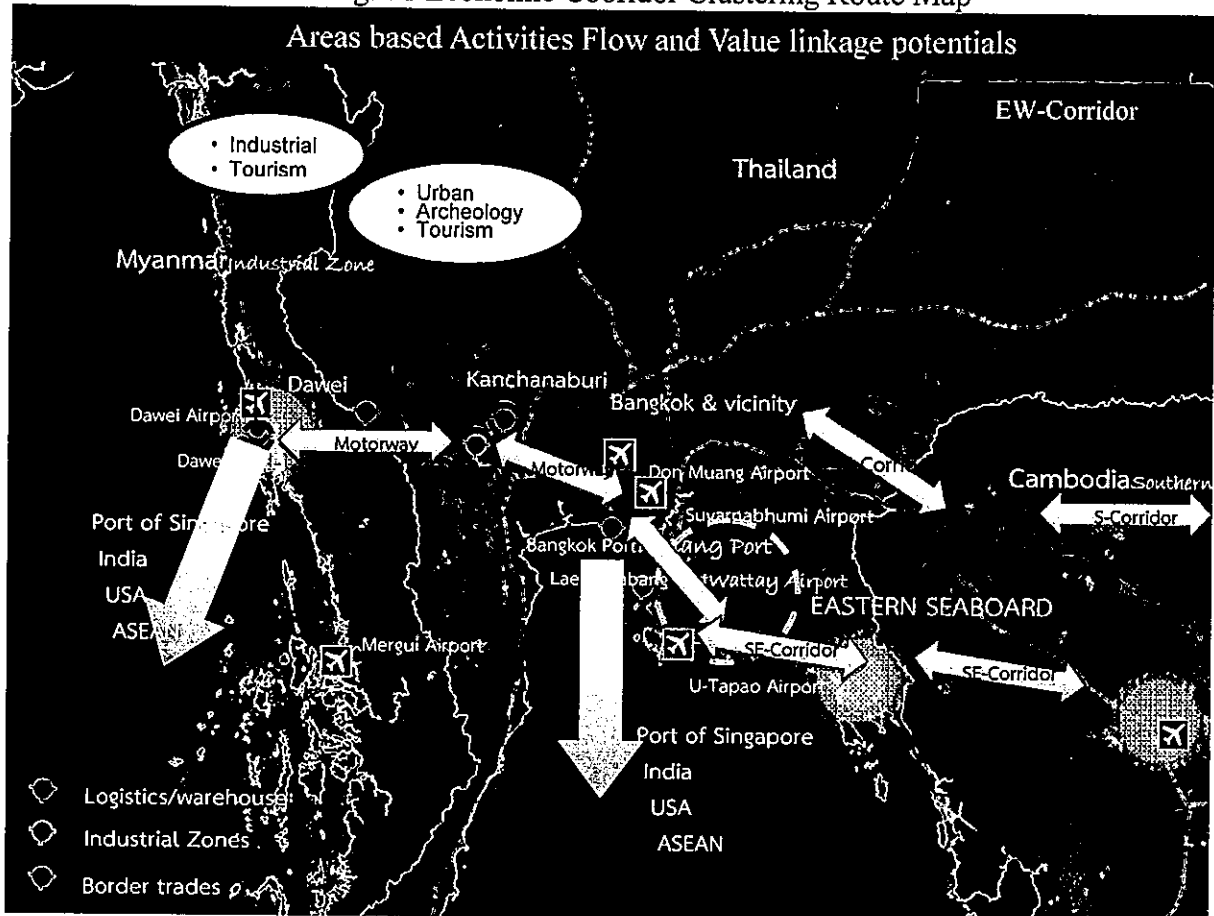


Fig. 12 Area-based Activities Flow and Value Linkage Potentials

Fig. 11 and Fig. 12 are also given to illustrate dynamics of flows and connectivity maps required; all move towards areas based impact.

Mapping the topography along the corridor is needed to create and update land cover and terrain data with production of national map series in scales from 1:25,000, maintaining the topographic landscape model (TLM). These should serve as the foundation for the vector data and the digital cartographic models (DCMs) for map symbolization and production, with complete integration of photogrammetry and 3D GIS to allow a wealth of products to be created.

Each DCM corresponding to one of the many map scales is required for urban planning. Also the links between the features of the TLM and DCM are to be made. This is of required special importance when changes in the real world to happen due to turning land to economic corridor.

For GIS Mapping, drones usage is to be proposed to help urban planning in association with such infrastructure as railways- protect land.

Through the use of GIS-Space technology, planning platform needs to generate precise, fully orthorectified 2D maps and 3D models from frame-based aerial imaging for urban system development. LiDAR is to be used as external data sources.

As the planning of this kind requires the most dynamic geospatial solution for driving enhanced decision making, the proposal should incorporate new mobility, analytics and big data management tool to develop creative interface. Smarter workflows and automated technologies are to be made to support the entire geospatial information life cycle, transforming multi-source content into dynamic and actionable intelligence policy (AIP).

Such planning platform and integrated solution must be designed to help to do work smarter and faster which synchronize all spatial technologies across desktop, server and mobile product lines.

For that matter, Multiple intelligence (Multi INT) fusion is required as an important component of TOR requirement. The ability to bring imagery intelligence, signals intelligence, human intelligence, measurement and other sources into an integrated analytics environment to ensure a powerful platform for such planning.

Individual sensor types are well-suited for certain environments, but not all. For example, optical sensors collect high resolution images during the day, but not at night. Light detection and ranging (LiDAR) collection can occur at night, but will not perform well in cloudy and rainy condition. Radar can collect at night and in cloudy conditions, but may not provide as high a resolution as other sensor type.

The best solution is then for planning analysts to work in an environment that supports all difference sources. Satellite imagery may serve as the canvas on which other dynamic data feeds are displayed. Together, these feeds combine to create a powerful and detailed depiction of the real world.

This TOR requires collecting dynamic information, using unmanned aircraft system video feeds – a series of still images taken over a period of time played back in cohesive fashion, with recognition of future technology.

Understanding the relationships among different sets of intelligence captured from different sources is crucial analysis. Temporal metadata associated with sensor collections are key for establishing the relationship among those collections and for interpreting additional details about unfolding events.

While important space technology is merely a means to an end, the ability to make this kind of planning is still a based activity, so activities required as;

Mapping Economic Corridor with satellite and airborne system

UAV for urbanization

1) Terrain conditions

- surveying plains, hills, mountains and urban areas under all types of weather conditions
- Especially in those deep forest locations, the use of airborne systems is very valuable

2) Data acquisition

- All flight lines have to be defined manually. The average flying height is set to about 300m above the ground, which would require result in a pixel resolution of approximately 10cm. The 120km-width corridor maybe subdivided into 16km segments.

The logo for GISTDA (Geospatial Information Science and Technology Development Agency) is located at the bottom center of the page. It features the word "GISTDA" in a stylized, handwritten-style font, with a circular graphic element to the left of the letters.

3) Ground control

- Setting the ground control points (GCPs) is required for geo-reference of the images.
- A minimum lateral image overlap of 50% and a minimum forward overlap of 80% are acceptable.
- Ground control points maybe set parallel to the first central string, towards each edge of the corridor.
- Showing the control point locations and the two parallel flight lines.
- This must provide the computation of point clouds from the images and the vectorization of buildings, roads, street lights, power lines, vegetation and existing railway lines on the corridor.

4) Result

- Over 50,000 images are needed to be captured during the course of the corridor mapping project.
- Require orthophotos and a 3D model with 10cm resolution and an average height accuracy of 15cm. The height error behaves as a function of the distance to the closest GCP. Overall, the 20cm accuracy requirement must be achieved. The UAV products are to be used as solutions to plan and engineer the railway route, urban industrial planning and form area-based innovation development policy.

For the Urban, Economic Corridor Planning and Infrastructure-Augmented Reality, integrated solutions shall be developed either as specific applications or as a subset of agriculture, water management or disaster management applications.

- The bidder shall propose a system architecture covering:
 - the end-to-end system from satellite imagery
 - the central system administration under the authority of the GISTDA and/or Department of Public Works and Town & Country Planning (DPT).
 - the solution facilities or installations at the local government offices
 - the applications and products to be used by individual solutions and/or on a village basis.

Instructions to Bidders

- The bidder shall propose the architectural design of the solution facilities and installations for the GISTDA and/or DPT and/or the local government offices including hardware, software and any third party products.
- The solution facilities and installations for the GISTDA and/or DPT and/or the local government offices shall be co-developed at the Space Krenovation Park (SKP) in the first instance to allow end-to-end verification and solution training before deployment and installation at the target sites.
- The satellite data to be used may include multispectral, hyperspectral, radar or other data as necessary according to the bidder design, but for any data not available from existing sources (THEOS-2 proposed sources or existing GISTDA downlinks from third party satellites), then the cost and implementation of extra downlinks, data purchase or other costs shall be detailed

Minimum requirement in relation to satellite imagery

Duties	Type of technology							Frequency of information				Data volume
	Optical			Radar								
	VHR	HMR	MLR	X	C	S	L	D/AH	W	M	Y	
Real-time map	X						X					DD
Planning and decision making	X									X	X	DD
Tax map	X							X			X	DD
Administrative region	X	X					X				X	DD
Population database	X	X									X	DD

- The bidder shall include data from Unmanned Aerial Vehicles (UAVs), aerial survey or other means
- The bidder shall propose additional sources of data with details of downlinks, cost and availability.
- The bidder shall include elevation modeling for subsidence monitoring and topographic mapping
- Data coverage shall be the whole of Thailand focusing on particular areas of density. However, the sensitive areas of Bangkok shall not be acquired.

Instructions to Bidders

- The bidder shall identify other data sources (aerial, in-situ or other), that are necessary to supplement the satellite data, with an estimation of data collection frequency and availability.
- The revisit times for data acquisition shall be specified by the bidder with a justification against the whole country coverage and more frequent monitoring of urban areas, major transport routes or infrastructure development
- The deliverables for solution facilities and installations shall provide the following:

Minimum requirement for solution deliverables

	Scale	Frequency of information						Coverage	Remark
		R	AH	D	W	M	Y		
Urban mapping, measuring and monitoring:									
• Land use map	1:4,000						X	EWC	OA > 85%
• Land use change	1:4,000						X	EWC	
• Infrastructure map (e.g. road, rail, canal, etc.)	1:4,000						X	EWC	OA > 85%
• Inundated area	1:4,000		X					EWC	OA > 85%
• Land subsidence	1:4,000						X	EWC	
• Aerosol optical thickness (AOT)	1:4,000			X				EWC	
• Vehicle tracking	1:4,000	X						EWC	
• Urban 4D map	1:4,000						X	EWC	
• DEM	1:4,000						X	EWC	
• Nightlight map	1:250,000			X				EWC	
Urban modeling:									
• Urban sprawl	1:4,000						X	EWC	
• Flood simulation & forecasting	1:4,000		X					EWC	
• Air pollution (e.g. PM10, PM2.5, CO, CO ₂ , NO ₂)	1:4,000			X				EWC	
• Urban heat island (UHI)	1:4,000		X					EWC	
• Emerging infectious diseases (EID) (e.g. MERS-Cov, Avian flu, SARs)	1:4,000		X					EWC	
Urban management:									
• Urban planning	1:4,000						X	EWC	
• Urban drainage & flood control	Variance		X					EWC	
• Traffic management	Variance			X				EWC	
• Air quality warning	Variance			X				EWC	
• Disease control	Variance		X					EWC	
• Tax map	1:4,000						X	EWC	
• Energy usage	Variance			X				EWC	

Instructions to Bidders

- The solution for individual users or local levels shall be user friendly (e.g. Thai-language, intuitive, interactive), shall be made available on mobile platforms (e.g. web, handheld, mobile phone, tablet) and shall provide:
 - Local development mapping
 - Transport and energy planning
 - A feedback mechanism allowing inputs from in-situ data from the solutions

In addition to the datasets specified above, the supplier may suggest other data types, frequencies and bandwidths (for example, LiDAR, Ocean color imaging, atmospheric monitoring etc.) that would benefit the solution needs and enhance the end-solution data applications and products.

In addition to the space-based data there is a need for complementary data from other sources. These sources could be aerial survey, Automated Unmanned Aerial Vehicles (UAVs), high altitude balloons, ground based installations (such as coastal radar), and mobile and personal ground survey data.

It is for the supplier to suggest an optimized mix of datasets to service the solution needs, and provide these in an integrated end-to-end system.

More details can be found related to previous sections dealing with the requirements for these applications and products.

Legend:

VHR = Very high resolution optical satellite (<1m), practically 0.5 m for THEOS-2

HMR = High-medium resolution optical satellite (1-5m)

MLR = Medium low resolution optical satellite (>5 m)

X = Radar X-band

C = Radar C-band

S = Radar S-band

L = Radar L-band

R = Real-time

AH = immediately when needed

D = daily

W = weekly

M = monthly

Y = yearly or longer

X = Technology which the advisor team (solution-design team) estimated to be sufficient for requirement

Δ = Technology which the advisor team believed can be used but may not be sufficient for the requirement, or there is not enough information for the advisor team to estimate

DDD = high data volume requirement (more than 2 times an area of Thailand)

DD = medium data volume requirement (between 1 and 2 times an area of Thailand)

D = low data volume requirement (less than 1 and 2 revisit time over an area of Thailand in a year)

OA = Overall accuracy

EWC = East-west corridor

EEZ = Exclusive economic zone



APPENDIX 4: REQUIREMENTS FOR PROVISION OF EXTERNAL DATA

It is foreseen that THEOS-2 solutions and applications will require a large number of remote sensing datasets with combinations of resolutions (spectral, spatial, temporal) and area of interest while the data sources can be that of space-borne, air-borne and / or ground sensors, incorporating the existing data as provided in the Annex. Crowd-sourcing data may also be included. Basic dataset requirement is listed in the table below.

The bidder shall analyze the solutions and applications requirements and propose a list of datasets that shall be made available during the Project Development Phase (sufficient for solutions and applications development) and the Project Operation Phase (sufficient for full operation of the system). Datasets during Project Development Phase shall be included in the THEOS-2 proposal with the duration covering the solutions and applications development, integration, test and user's training. Apart from satellite constellations, the bidder may propose data from other sensors/sources such as aerial photos, Unmanned Aerial Vehicle, high altitude balloon, etc.

Data from the satellites proposed in THEOS-2 system in conjunction with that from the external data sources shall be able to provide monthly cloud free images over the area of interest required by the solutions/applications (imaging window should span within the same month).

Should the proposal include installation of additional direct receiving stations; the bidder shall include the relevant design and / or modifications to the existing receiving station under the multi-mission operation concept.

The bidder shall quote the yearly datasets access fee the 10-year Project Operation Phase as an option.

Basic dataset requirement		
Resolution (m)	Frequency	
	Nominal situation (countrywide / area of interest)	Emergency situation / specific areas
Optical		
1000	Hourly	-
50-100	4 times / day	-
10-50	Weekly	1-2 times / day
1-10	Quarterly	1-2 times / day
0.5-1	Biannually	Every 1-2 days

Instructions to Bidders

Radar		
50-100	once every 2-3 days	2 times / day
10-50	Weekly	1-2 times / day
1-10	Bimonthly	1-2 times / day
0.5 - 1	Bimonthly (surveillance area)	1-2 times / day
UAV / Low Altitude Platforms		
0.1 – 0.5	100 sq.km. / day	Situation-based
Ground Sensors		
< 0.1	1-10 sq.km. / day	Situation-based

APPENDIX 5: REQUIREMENTS FOR VERY HIGH RESOLUTION SATELLITE AND SMALL SATELLITE SYSTEMS

1 Main Satellite (Thaichote-2)

The bidder shall provide a satellite platform includes a VHR (very high resolution) imaging instrument and the necessary accommodation for the VHR imaging instrument in supporting of Thaichote-2 operations.

The Thaichote-2 is an agile three-axis stabilized satellite that will be launched into a sun-synchronous low earth orbit. The primary objective of Thaichote-2 is a VHR imaging around the globe for geo-informatics applications on social, economic and environmental sectors such as multi scales land use planning and administration, integrated water management, disaster and geo-hazard management, agricultural and food security, natural resources and ecosystem management, urban, economic corridor, infrastructure planning, social wellness and national security. And the most importantly, the VRH images will serve the integrated platform which will be implemented under the THEOS-2 program.

The bidder shall provide details or solid evidence or heritage corresponding to the proposed satellite.

To fulfill the scope of THEOS-2 mission, the requirements of Thaichote-2 are listed as follows:

1.1 Mission Requirements

- Any in-space components (satellites) shall be supplied on a delivery-in-orbit basis including launch, insurance and in-orbit validation and all the related ground facilities / software processors.
- Mission lifetime shall be at least 7 years, excluding the storage life of 3 years.
- Reliability
 - The satellite shall be designed with adequate redundancy (of subsystems and critical devices), such that single point failures are avoided to the most extent, in order to ensure successful operation until the end of lifetime.
 - The satellite shall be designed to support the mission operations with reliability not less than 0.65 after 7-year lifetime.
- Sun-Synchronous Orbit (for Global Coverage), attitude above 600 km

Instructions to Bidders

- Local Solar Time at descending node shall be between 9:30-10:00 AM
- Revisit time (at 10 degree N latitude) shall be less than 3 days.
- Field of Regard (largest incidence angle of any covered target within revisit time) shall not exceed 30 degree on nominal acquisition.
- Satellite shall be capable of operating simultaneously in the Panchromatic and Multispectral imaging modes.

1.2 Payload Requirements

- The design of the payload shall consider the quality of the panchromatic – multispectral fusion product.
- Ratio between GSD of MS/PAN shall not exceed 4:1
- Multispectral (MS) sensor shall be Blue, Green, Red, NIR (other channels such as SWIR, MWIR, LWIR, Red Edge, Ocean Blue etc. may be suggested by the supplier)
 - Bidder shall provide the detailed specification of the MS sensor such as sensor technology, range of spectral band, swath width, etc.
 - Resolution (native GSD) shall be 2 m or better
- Panchromatic (PAN)
 - Bidder shall provide the detailed specification of the PAN sensor such as sensor technology, range of spectral band, swath width, etc.
 - Resolution (native GSD) shall be 0.5 m or better
 - Swath width at nadir shall be 20,000 x GSD or better
- Remote Sensing Instrument duty cycle shall be no less than 10% of the orbit period (continuous acquisition)
- The optical payload shall provide digital data no less than 11bits.
- The optical payload shall provide to the user the possibility to adjust the signal dynamic to the expected scene radiance, by selecting for each band the gain of the detection chain among a set of more than 4 predefined values.



Instructions to Bidders

- Spectral Radiance
 - The bidder shall provide the radiance levels for Low Radiance, Typical Radiance and Saturation Radiance. The radiance levels are apparent spectral radiance values, at instrument input and averaged over their respective spectral domain.
 - The bidder shall provide the figure factor of the incidence of radiance levels in temporary excess of the saturation radiance level (such as those due to specular reflection of solar energy from high reflectivity surfaces, shall not permanently impair the ability of the mission equipment to collect imagery data).
 - The bidder shall provide the figure of delay time to resume the collection of valid imagery data following the termination of an interval during which the received radiance exceeds the saturation radiance.
- The bidder shall provide the number of image acquisition sequences.
- The bidder shall propose the lossless data compression scheme.

1.3 Image Quality Requirements

- Satellite Data Products
 - The satellite products shall consist of
 - image telemetry data (image data and auxiliary data)
 - ground calibration data (geometric model, radiometric model, geometric and radiometric calibration ground measurements), delivered before launch
 - The image telemetry data coded on at least 11 bits.
 - Deletion of image shall be selectable between automatic (after downlink) or manual.
 - Compression Ratio shall be selectable during mission programming.

- Geometric Image Quality

The bidder shall provide the detail of

- width of the Panchromatic image at nadir and at the nominal altitude;
- width of the Multispectral image at nadir and at the nominal altitude;



Instructions to Bidders

- ground sampling distance (angular spacing of the measuring increments or pixel angular sampling distance) of Panchromatic image;
 - ground sampling distance (angular spacing of the measuring increments or pixel angular sampling distance) of Multispectral image;
 - image sampling period of Panchromatic image and Multispectral image;
 - image distortion, knowledge of the image distortion, stability of the integration time.
- Radiometric Image Quality
 - The bidder shall provide the range of each spectral band and the radiance from each surface element.
 - MTF shall be (at system level after radiometric corrected)

PAN	0.1 or better
Blue	0.24 or better
Green	0.24 or better
Red	0.24 or better
Near IR	0.24 or better

- SNR shall be than (at system level after radiometric corrected)

PAN	80 or better
Blue	100 or better
Green	100 or better
Red	100 or better
Near IR	100 or better

- The uniformity of the radiometric response inside each spectral band shall be better than 10%.
- The uniformity of the darkness response inside each spectral band shall be better than 25%.

1.4 Satellite Performance Requirements

- Attitude/Orbit Determination and Control System (AODCS)
 - The satellite shall provide a real-time attitude determination function and shall provide an attitude reference, satisfying all mission as well as in-orbit diagnostic evaluation requirements.

Instructions to Bidders

- All necessary sensor raw data outputs and GPS data, required in controlling the satellite and performing post attitude processing from the ground, shall be fully transmitted in playback.
- Pointing accuracy shall be better than 0.02 degree per axis (3σ).
- Localization and pointing knowledge:
 - Ground location accuracy of the imagery is 50 m or better without GCPs (Ground Control Points) (CE90) and 2 panchromatic pixels or better with GCPs (3σ).
 - Satellite shall provide pointing knowledge on board to remote sensing equipment with geolocation error less than 30 m or better without GCP.
 - The mathematical model, e.g. the physical rigorous sensor model and rational polynomial coefficient, for GCP to achieve at least or better than 2 pixels shall be provided.
- Acquisition & Safe Hold Mode
 - The Acquisition & Safe Hold Mode shall operate without any knowledge of the spacecraft position.
 - The Acquisition & Safe Hold Mode shall be able to operate without ground support during more than 7 days.
 - The bidder shall provide the specification detail of
 - Angular rate for performing initial rate damping
 - Number of orbit for performing sun acquisition
- Orbit Control Mode
 - The satellite shall accommodate the following delta-V in the propellant budgets with 20% margins for orbit transfer, launch vehicle separation maneuver, orbit maintenance, attitude control for both normal and contingency operation, propellants residuals and loading errors.
 - The satellite shall be able to perform a thrust at any position on the orbit.
 - The satellite shall be able to perform a thrust along any axis in the Roll/Pitch plane of local orbital frame.

Instructions to Bidders

- The bidder shall provide
 - o the minimum and maximum values of ΔV for one single thrust in nominal conditions. The limit values for degraded cases (after actuator failure) shall be provided.
 - o the figure of pointing accuracy during thrust
 - o the minimum duration between two thrusts
- The satellite shall be able to recover full performances less than two orbits after one thrust.
- Agility requirements
 - Satellite shall have agility better than 45 degree/30 sec per axis slew maneuver.
- Power System
 - Power margin of the satellite shall be higher than 20%.
 - Satellite minimum SOC (battery state of charge) shall be sufficient for safe mode operation for 7 days without ground intervention.
- Communication performance
 - The bit error rate (BER) shall be better than 10^{-6} for telemetry downlink and 10^{-7} for command uplink.
 - The bit error rate of image data downlink shall be better than 10^{-6} after error correction for image data.
- The TT&C subsystem shall have link characteristics compatible with the CCSDS-recommended channel coding standard.
- Payload Data Handling
 - The satellite shall be capable of providing store-and-dump capability for panchromatic and multispectral data when these image data are not downlinked in real time.
 - When Panchromatic and Multi-spectral data are acquired simultaneously for real time downlink, the system shall be capable of multiplexed data downlink,



by interleaving in the downlink-band telemetry panchromatic and multispectral files.

- The image data transmission format shall be in compliance with the relevant Consultative Committee on Space Data Systems (CCSDS) standards. It shall include auxiliary data that encompasses instrument parameters (gain level, detector temperature, etc.) and satellite parameters (time, position, attitude), which are necessary for the further ground processing of image data.
- The image digital data can be processed by general off-the-shelf software.

1.5 Launching Requirements

- Launch/Orbit Insertion
 - The satellite shall be capable of transferring to its operational orbit from a circular parking orbit by ± 20 km altitude margin, with in an inclination by ± 0.1 degree margin to the mission orbit.
- Initial Mission Orbit
 - The initial mission orbit accuracy shall be within 100 m for altitude and 0.01 degree for inclination when satellite is transferred into mission orbit.

2 Small Satellite

The bidder shall provide a satellite platform includes a HR (high resolution) imaging instrument and the necessary accommodation for the HR imaging instrument in supporting of Small Satellite operations.

The Small Satellite is an agile three-axis stabilized spacecraft that will be launched into a LEO for earth observation. The primary objective of Small Satellite project is the capacity building of satellite development, assembly, integration and testing at SKP (Space Krenovation Park). The images taken by the HR instrument, around Thailand and ASEAN region will serve the geo-informatics applications. The secondary objective is to make use of Thailand-based manufactured materials, equipments and devices for building the satellite subsystems and satellite structure. In addition, the development under Small Satellite project has to providing opportunities for Thai SMEs and startup to get into the space industrial business.

The requirements of Small Satellite are listed as follows:

2.1 Mission Requirements

- Any in-space components (satellites) shall be supplied on a delivery-in-orbit basis including launch, insurance and in-orbit validation.
- Mission lifetime shall be at least 3 years
- Reliability
 - The satellite shall be designed to support the mission operations with reliability not less than 0.65 after 3-year lifetime.
- Orbit requirements
 - The satellite orbits shall be significantly designed as gap filler of Thaichote-2 visibility
 - Orbit inclination 30 - 35 degree
 - Orbit altitude 550 to 800 km
- Revisit time shall be less than 2 days.
- Field of Regard (largest incidence angle of any covered target within revisit time) shall not exceed 30 degree on nominal acquisition.
- Satellite shall be capable of operating simultaneously in the Panchromatic and Multispectral imaging modes.

2.2 Payload Requirements

2.2.1 Primary Payload : HR instrument

- The design of the optical payload shall consider the quality of the panchromatic – multispectral fusion product.
- Ratio between GSD of MS/PAN shall not exceed 4:1
- Multispectral (MS) sensor shall be Blue, Green, Red, NIR (other channels such as SWIR, MWIR, LWIR, Red Edge, Ocean Blue etc. may be suggested by the supplier)
 - Bidder shall provide the specification details of the MS sensor such as sensor technology, range of spectral band, etc.

The logo of the Geological Survey of Thailand (GISTDA) is displayed in a stylized, cursive font.

Instructions to Bidders

- Resolution (native GSD) shall be 8 m or better
- Swath width at nadir shall be 2,000 x GSD or better
- Panchromatic (PAN)
 - Bidder shall provide the specification details of the PAN sensor such as sensor technology, range of spectral band, etc.
 - Resolution (native GSD) shall be 2 m or better
 - Swath width at nadir shall be 8,000 x GSD or better
- Remote Sensing Instrument duty cycle shall be no less than 10% of the orbit period (continuous acquisition).
- The optical payload shall provide digital data no less than 11 bits.
- The optical payload shall provide to the user the possibility to adjust the signal dynamic to the expected scene radiance, by selecting for each band the gain of the detection chain among a set of more than 4 predefined values.
- Spectral Radiance
 - The bidder shall provide the radiance levels for Low Radiance, Typical Radiance and Saturation Radiance. The radiance levels are apparent spectral radiance values, at instrument input and averaged over their respective spectral domain.
 - The bidder shall provide the figure factor of the incidence of radiance levels in temporary excess of the saturation radiance level (such as those due to specular reflection of solar energy from high reflectivity surfaces, shall not permanently impair the ability of the mission equipment to collect imagery data).
 - The bidder shall provide the figure of delay time to resume the collection of valid imagery data following the termination of an interval during which the received radiance exceeds the saturation radiance.
- The bidder shall provide the number of image acquisition sequences.

2.2.2 Secondary Payload: AIS/ADS-B instrument

- Instrument shall be designed for the requirements of ground based Automatic Identified System / Automatic Dependent Surveillance – Broadcast (AIS/ADS-B) surveillance, as given by the EUROCAE, ICAO and EUROCONTROL documents.
- AIS/ADS-B instrument shall be used in Applicable Solutions of
 - Collision avoidance: shall be able to identify vessel individually, along with its specific position and movements, enabling a virtual picture to be created in real time, to avoid collisions among large vessels at sea that are not within range of shore-based systems;
 - Fishing Fleet Monitoring and Control: shall be able to track and monitor the activities of their national fishing fleets;
 - Accident investigation: shall provide accurate historical data on time, identity, GPS-based position, compass heading, course over ground, speed (by log/SOG), and rates of turn, rather than the less accurate information provided by radar;
 - Others related, bidder can propose in discretion.

2.3 Image Quality Requirements

- Satellite Data Products
 - The satellite products shall consist of
 - image telemetry data (image data and auxiliary data)
 - ground calibration data (geometric model, radiometric model, geometric and radiometric calibration ground measurements), delivered before launch
 - The image telemetry data coded on at least 8 bits.
 - Deletion of image shall be selectable between automatic (after downlink) or manual.
- Geometric Image Quality

The bidder shall provide the detail of

Instructions to Bidders

- width of the Panchromatic image at nadir and at the nominal altitude;
 - width of the Multispectral image at nadir and at the nominal altitude;
 - ground sampling distance (angular spacing of the measuring increments or pixel angular sampling distance) of Panchromatic image;
 - ground sampling distance (angular spacing of the measuring increments or pixel angular sampling distance) of Multispectral image;
 - image sampling period of Panchromatic image and Multispectral image;
 - image distortion, knowledge of the image distortion, stability of the integration time.
- Radiometric Image Quality
 - The bidder shall provide the range of each spectral band and the radiance from each surface element.
 - MTF shall be (at system level after radiometric corrected)

PAN	0.2 or better
Blue	0.24 or better
Green	0.24 or better
Red	0.24 or better
Near IR	0.24 or better

- SNR shall be (at system level after radiometric corrected)

PAN	80 or better
Blue	100 or better
Green	100 or better
Red	100 or better
Near IR	100 or better

- The uniformity of the radiometric response inside each spectral band shall be better than 10%.
- The uniformity of the darkness response inside each spectral band shall be better than 25%.

2.4 Satellite Performance Requirements

- On Board Computer (OBC)



Instructions to Bidders

- OBC shall be the functions of central processing resource and interfaces with all subsystems for monitoring and reconfiguration.
- OBC shall provide (at least)
 - capability to simultaneously record and downlink Playback Telemetry data
 - capability to reset itself by requesting from ground station
 - capability to manage sequentially the priority of Telecommand
 - capability to reprogram the Telemetry format via ground command
 - capability to record and reproduce the data multiplexed at the mission data coding
 - capability to command memory for at least 48 hours of autonomous operations
 - capability to protect the mission data by special encoding as an error correction encoding
- Bidder shall provide the specification details of
 - data rate for Telemetry store-and-dump capability
 - data rate for Real-Time Telemetry capability
 - data rate for receiving uploaded ground commands
 - storage capacity for image digital data
- Attitude/Orbit Determination and Control System (AODCS)
 - The satellite shall provide a real-time attitude determination function and shall provide an attitude reference, satisfying all mission as well as in-orbit diagnostic evaluation requirements.
 - All necessary sensor raw data outputs and GPS data, required in controlling the small satellite and performing post attitude processing from the ground, shall be fully transmitted in playback.
 - Pointing accuracy shall be better than 0.1 degree (1σ).
 - Attitude determination accuracy shall be better than 0.02 degree at 1σ .
 - Localization and pointing knowledge

Instructions to Bidders

- Ground location accuracy of the imagery is 250m or better without GCPs (Ground Control Points) (CE90) and 2 panchromatic pixels or better with GCPs (3σ)
- Satellite shall provide pointing knowledge on board to remote sensing equipment with geolocation error less than 200m or better without GCP.
- Acquisition & Safe Hold Mode
 - The Acquisition & Safe Hold Mode shall operate without any knowledge of the spacecraft position.
 - The Acquisition & Safe Hold Mode shall be able to operate without ground support during more than 7 days.
 - The bidder shall provide the specification details of
 - Angular rate for performing initial rate damping
 - Number of orbit for performing sun acquisition
- Orbit Control Mode
 - The satellite shall accommodate the following delta-V in the propellant budgets with 20% margins for orbit transfer, launch vehicle separation maneuver, orbit maintenance, attitude control for both normal and contingency operation, propellants residuals and loading errors.
 - The satellite shall be able to perform a thrust at any position on the orbit.
 - The satellite shall be able to perform a thrust along any axis in the Roll/Pitch plane of local orbital frame.
 - The bidder shall provide
 - the minimum and maximum values of ΔV for one single thrust in nominal conditions. The limit values for degraded cases (after actuator failure) shall be provided.
 - the figure of pointing accuracy during thrust
 - the minimum duration between two thrusts
 - The satellite shall be able to recover full performances less than two orbits after one thrust



Instructions to Bidders

- Agility requirements
 - Satellite shall have agility better than 45 degree/30 sec per axis slew maneuver
- Power System
 - Power margin of the satellite shall be higher than 20%.
 - Satellite minimum SOC (battery state of charge) shall be sufficient for safe mode operation for 7 days without ground intervention.
 - batteries and solar cells shall not be degraded and lost at least 3 years
 - The bidder shall provide the specification details of power system includes
 - power budget for each operational mode
 - the minimum power level for performing all subsystems
 - depth of discharge (DOD) in corresponding to satellite lifetime and mission scenarios
 - battery charge regulation performed by the on-board software
 - power management procedures in normal mode and the case of inconsistency (e.g. over-voltage or battery over-discharge)
- Communication requirements
 - The bidder shall provide the specification details of S-band system for TT&C
 - The bidder shall provide the specification details of X-band system for image data downlink
 - The bit error rate (BER) shall be better than 10^{-6} for telemetry downlink and 10^{-7} for command uplink.
 - The bit error rate of image data downlink shall be better than 10^{-9} after error correction for image data.
 - The TT&C subsystem shall have link characteristics compatible with the CCSDS-recommended channel coding standard.
- Payload Data Handling

Instructions to Bidders

- The satellite shall be capable of providing store-and-dump capability for panchromatic and multispectral data when these image data are not downlinked in real time.
- When Panchromatic and Multi-spectral data are acquired simultaneously for real time downlink, the system shall be capable of multiplexed data downlink, by interleaving in the downlink-band telemetry panchromatic and multispectral files
- The image data transmission format shall be in compliance with the relevant Consultative Committee on Space Data Systems (CCSDS) standards. It shall include auxiliary data that encompasses instrument parameters (gain level, detector temperature, etc.) and satellite parameters (time, position, attitude), which are necessary for the further ground processing of image data.
- The image digital data can be processed by general off-the-shelf software.
- Thermal Control
 - Shall be comprised an active/passive thermal control system
 - The satellite shall be insulated from the space environment by multi-layer insulation blankets. The radiator areas shall be provided with low solar absorptance and high infrared emittance to reject waste heat.
- Structure
 - The bidder shall use the Thailand-based manufactured materials such as aluminum, composite material or comparable materials.
 - Shall have a separable structure consisting of the antenna lower, central structure, and Localisation using Appearance of Prior Structure (LAPS) support structure, thus facilitating its assembly and transportation

2.5 Launching Requirements

- Orbit inclination has been specified in the Orbit Requirements.

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2.6 Satellite Simulator

Satellite (Small Satellite) simulator is used for small satellite development, engineering training, flight operator training, satellite anomaly resolution, and flight software patch validation.

Satellite simulator shall be a software basis with modeling all satellite hardware (sensors & actuators) dynamics, including the redundant sides if there are.

Satellite simulator shall have the flight software and the On Board Computer Emulator, the same as the real satellite.

Satellite simulator shall provide the following simulated functions as a minimum:

- satellite dynamics, including mass distribution & propulsion, as the minimum,
- all satellite modes and mode transaction,
- anomaly responses and the failover transaction,
- telemetry/command interaction,
- payload operation response and payload image data,
- flight software patch,
- ground station visibility, antennae & RF links quality for communication,
- internal & external thermal conditions, generated heat sources & dissipation
- and all environments, including atmospheric drag, orbits, earth/sun/moon looking angles, thermal conditions, as the minimum.

Satellite simulator shall provide the same telemetry/command and dynamics as the real satellite.

2.7 Issues on Technology Transfer

- The knowledge of satellite development, optical and AIS/ADS-B payloads development in system and subsystem levels shall transfer to Thai Engineers
- The satellite development including assembly, integration and test shall be located at Space Krenovation Park (SKP)
- The development of satellite flight software shall be provided with satellite simulation and subsystems functional testing

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- Payload instruments shall be proved and verified including software operations of AIS/ADS-B monitoring system

3 Launch vehicle (LV)

Satellite shall be designed to be compatible with the minimum of (2 or 3) launchers. Candidates LV shall be able to deliver satellite to the initial orbit such that no greater than 12% of satellite's own propellant is required for additional orbit transfer.

Reliability of all candidates LV shall be greater than 90%.

Risk assessment shall be performed on issues such as main LV unavailability and drop zone authorization to avoid launch delay in such case

4 Midstream

THEOS-2 program shall include the ground segment that must be able to support the whole mission cycle (start from LEOP until EOM). For nominal operation, the ground segment shall be able to support, start from programming of the imaging acquisition, satellite control, through all the procedures until the image production and products archiving.

The ground segment consists of three main elements, which are Control Ground Segment (CGS), Image Ground Segment (IGS) and TT&C Facilities and Receiving Station. Diagram of the Ground Segment is shown in the figure below, details for each element and further operation considerations, i.e. dual-use operation will be given in the following sections.

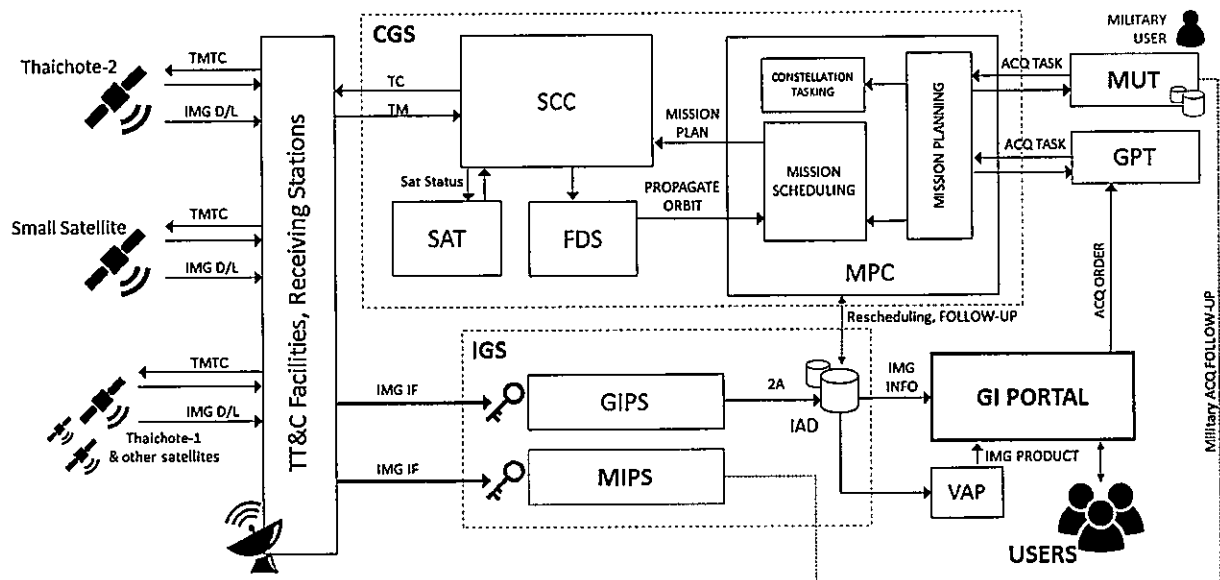


Fig. 13 THEOS-2 satellites operation ground segment

Instructions to Bidders

Acronyms

CGS: Control Ground Segment
SCC: Satellite Control Center
SAT: Satellite Engineering
FDS: Flight Dynamics System
MPC: Mission Planning Center
MUT: Military User Terminal

GPT: GISTDA Planning Terminal
IGS: Image Ground Segment
GIPS: GISTDA Image Processing System
MIPS: Military Image Processing System
IAD: Image Archive Database,
VAP: Value Added Processes

4.1 Control ground segment (CGS)

The Control Ground Segment (CGS) shall be able to support, at least, Thaichote-2 and Small Satellite. Nominal routine operation of the CGS shall not require more than 180 man-hours per week to operate 3 Earth observation satellites at minimum. The bidder shall propose the nominal routine operation structure and procedure, which include, at minimum, the work breakdown structure and function descriptions of the proposed operation, standards and implementation plan in THEOS-2 program proposal.

The bidder must support/assist GISTDA to develop and modify GISTDA current systems used in CGS for THEOS-1 operation in order to be interoperable with Thaichote-2, Small Satellite and other operation system.

- The control ground segment shall be compatible with in-orbit operations and on-ground testing.
- The control ground segment shall monitor the health of the satellite and provide the interface to command the satellite.
- The control ground segment and mission planning systems shall be compatible with running multiple missions.
- The simulations system shall provide facilities to run and debug the operating procedures by emulating the satellite systems with a representative on-board software image.
- The commanding to the satellite will be from a single source, however there may be both civilian and security inputs to the missions planning system which shall handle prioritization and secure masking.

The Control Ground Segment (CGS) for THEOS-2 shall comprise of, at minimum, the following subsystems;

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4.1.1 Mission Planning Center (MPC)

The mission planning center is a component of the CGS for preparation, computation, and optimization of the satellite payload programming for Thaichote-2 and Small Satellite. The requirements of this system are given in details as follows:

- MPC shall allow the operators to manage, generate satellite operation work plan (deposit, cancel, follow-up) and perform functional management (administration, storage, archive, statistical analysis) for the payload programming requests.
- The system (MPC/GPT) shall have the interfaces with geographical map background. The operator shall have the possibility to add layers of data, for example, cloud coverage, etc. This interface will be used for input of the Area of Interest (AOI) and for programming request management.
- Verify programming request parameters when it is relevant during the input. Any erroneous parameter value shall be notified to the user.
- It shall perform the following task according to programming request analysis:
 - Split the area of request acquisition into images acquisition strips.
 - Allow the acquisition request input in different modes, which include single acquisition, routine acquisition, etc.
 - Compute and determine imaging opportunities for each strip of the request, taking into account satellite constraints and limitations.
- It shall provide satellite payload programming plan (image acquisition and data transmission) according to current requests. The payload programming must be compatible with the satellite system constraints such as the availability of satellite resources, downlink, agility, power budget, etc.), as well as the feasibility and the validity of imaging requests.
- It shall compute payload working plan on a daily basis, taking into account the system constraints, the associated ground segment pass plan, and meteorology condition. It shall allow the user to select between two methods to compute the payload working plan which are:

Instructions to Bidders

- Generate payload working plan based on optimization aiming to maximize the utilization of the satellite.
- Assign the image acquisition order manually.
- It shall be able to update and generate automatically the mission plan according to all of the requested acquisition order and seamlessly operable with other CGS systems.
- The MPC shall allow GISTDA to add additional earth observation satellite if needed. All of the required earth observation satellite parameters that is needed to be configured in order to use with MPC shall be listed and clarify in the MPC Interface Control Document (MPC-ICD).

4.1.2 Satellite Control Center

The function of this system is to perform the TT&C of the satellite, transmit the commands to the satellite and monitor the satellite's status and integrity. The requirements of this system are given in details as follows:

- Preparation for the uplink of the satellite mission plan, telecommand and the downlink of the satellite telemetries respectively. The system shall be able to perform in both manually and automatically when the satellite is in visibility.
- The system shall be able to monitor satellite telemetries automatically and detect any faults and errors according to the predefined conditions and threshold.
- The system shall be able to display the data in the form of graphs, states, values, etc. In both real time telemetry downlink mode and the playback telemetry mode.
- Archiving of telemetry data used for the a posteriori monitoring and analysis of the fine trends of onboard parameters.
- The system shall be able to execute the set of commands/procedures to control functions for satellite operations and maintenance, including command generation and execution, scheduling, navigation and satellite



Instructions to Bidders

performance analysis for all of operation phase (LEOP, Commissioning, Routine, Recovery, End of Mission, etc. ...).

- Satellite Control Centre shall be able to incorporate the necessary safety criteria to prevent potentially catastrophic commands from being processed by direct input into the command system, and develop detailed operational procedures to ensure all real-time commands receive analysis, verification, and proper approval before radiation to the satellite.
- The system shall be able to manage multiple satellites.
- Command shall be encrypted with ciphering key via ground authentication module to verify authenticity of command.
- The system shall be able to archive the telemetry to be used for the posteriori monitoring and analysis of the trends and health of satellite systems.
- Satellite Control system shall apply the CCSDS data system standards.
- Satellite Control system shall capture and archive the following data sets received or created during the mission operation:
 - All telemetry data received on the ground.
 - All commands sent to the satellite.
 - All execution sequences and processing logs.
- Satellite Control Center shall be able to integrate seamlessly with MPC, FDS and TT&C facilities and operate autonomously according to the predefined satellite control schedule.

4.1.3 Flight Dynamics System (FDS)

The FDS system is used for high precision satellite orbit determination and orbit propagation for earth observation satellite operation. This system is to be used as an orbital data source for mission planning center. The requirements for FDS are as follows

- Determine satellite orbital ephemeris propagation for MPC based on the downlinked satellite localization telemetries.

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Instructions to Bidders

- Determine the maneuver plan and requirements for satellite station-keeping and collision avoidance by also taking into account any necessary external inputs.
- FDS shall be able to interoperate seamlessly with CGS system. For routine operation, FDS shall be able to operate autonomously.

4.1.4 Technical Support and Control Ground Segment Compatibilities

The bidder must provide GISTDA all of the necessary requirements, documentations, specifications and technical support in order to allow GISTDA to develop/modify GISTDA's system to be compatible and interoperable with Thaichote-2 and Small Satellite.

4.2 Image ground segment (IGS)

The bidder must support/assist GISTDA to develop and modify GISTDA image production system (SIPRO) and image archiving system (GASS) in order to be interoperable with Thaichote-2, Small Satellite and other operation system.

All of the necessary requirements, information should be provided to GISTDA through the knowledge/technology transfer plan. This plan should be clarified in details with the corresponding timeline and requirements. It should be given in the proposal that will be submitted to GISTDA.

*** GISTDA should be able to deploy multiple decryption/deciphering systems on its own.

4.3 TT&C Facilities and Receiving Stations

Currently GISTDA has already deployed two S-band antennas (Tx and Rx) and two X-band antennas (Rx). In THEOS-2 program the bidder should provide one antenna system for TT&C additionally, and provide the modification for the existing X-band system in order to operate with Thaichote-2 and Small Satellite. The requirements and details are as follows;

4.3.1 Antennas for TT&C

The TT&C antenna and system shall be provided at least according to these requirements:

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Instructions to Bidders

- The antenna system shall be able to operate with Thaichote-1, Thaichote-2 and Small Satellite satellites and compatible with the ground system as listed in 4.1.
- Antenna tracking shall be able to operate manually by given antenna pointing commands and shall be able to operate automatically with TLE data.
- The antenna tracking mode shall comprise of program track (by TLE) and auto-track mode (signal strength tracking).
- During tracking, the tracking control system shall be able to switch automatically between the program track, and auto-track mode to ensure the continuity of the signal reception.
- Tracking shall perform with high accuracy with the tracking error not to be exceeded 0.05 degrees (rms).
- The antenna system shall be able to start the acquisition from 5 degrees elevation maximum.
- The antenna control system should have a monitoring and control (M&C), including redundant system. The system shall be able to switch automatically between the nominal and redundant system to ensure the continuity of the signal reception.
- The antenna system shall be able to control remotely from the external ground operating system through the secure link.
- The M&C system shall be able to control multiple antennas. The bidder should assist GISTDA to configure the provided M&C system with GISTDA existing S-band antenna.
- The M&C system shall be able to operate multiple antennas simultaneously, with the possibility to perform the automatic scheduling.
- For reliability, availability shall be better than 97 percentages, maximum downtime shall be less than 20 hours, and mean time to repair (MTTR) shall be less than 2 hours.



4.3.2 X-band antennas

The existing of two X-band antenna systems shall be modified to fulfill these requirements:

- The antenna system shall be able to operate with Thaichote-2 and Small Satellite satellites and compatible with the ground system as listed in 4.2.
- The antenna system shall be able to operate with very high bit rate according to the image is very high resolution, big data.
- The demodulator shall be separated for two channels supporting dual uses with ciphering key in each channel.

4.4 Archive and catalogue

- The archive system shall be able to ingest the existing GISTDA archive (Landsat data back to 1978, THEOS-1 data, third-party data).
- Data management, archiving and distribution system should be able to handle heritage, current and future mission data and non-space data. It shall have open interfaces to adapt to new data delivery systems. Where possible, specific hardware should be avoided.
- Data management, archive and delivery systems shall support massive computing gateways. They shall not be proprietary encapsulated. Data should be accessible for virtual processing systems, to be deployed on private/public clouds. Such virtual processors could run large scale value adding services.
- Data distribution systems shall support up to date data and web delivery protocols. New protocols and interfaces shall easily be integrated.

4.5 Image processing ground segment / image processing

- The system shall be able to process the data from the THEOS-2 satellites, from the constellation and third-party systems defined by the bidder, and the current downlinks operated by GISTDA.
- The software and algorithm for data decompressing / decoding shall be provided.



Instructions to Bidders

- The throughput of the image processing shall be sufficient to process all data received from the in-space assets without resorting to archive (automatic L1A, L2A, and L3 production without GCP).
- The image processing shall be replicable and scalable and shall not contain any proprietary elements. The image processing shall not be based on specific operating systems and hardware. Preferably, the source code shall be provided.
- The ground segment data systems shall allow supporting near real time applications, giving processing priority to urgently needed data and directly feeding this data to fast post-processing and service systems. Priority processing – i.e. for security purposes, shall be performed within 30 minutes of data access.
- The processing shall be as automated as possible from customer order to delivery.
- The bidder shall detail automated helpdesk functions, human resources needs and modes of delivery for image and product dissemination.
- Support image production on different levels:
 - Level 1A Radiometric corrected
 - Level 2A Radiometric and Geometric corrected
 - Level 2B Radiometric and Geometric corrected with GCPs
 - Level 3 Radiometric and Geometric corrected with DEM and with and without GCPs
- Support external inputs: GCPs, DEMs
- Support automatic, semi-automatic (automatic GCPs registration with manual adjustment capability), manual processing. For automatic and semi-automatic, image to image and chip database registration shall be included; the former is preferred.
- Shall be able to automatic processing (ortho-rectification) not less than 60 scenes per day (full frame) and support both scene by scene processing and seamless mosaic processing
 - For scene by scene: naming format of the scene shall be customizable

Instructions to Bidders

- For mosaiking: shall support unlimited file size (uncompressed) and shall be subdivided into map-sheet series
- For mosaiking: cloud removal algorithm and cutline editing shall be included.
- Shall support coefficient adjustment for RPC to further improve the location accuracy
- Shall support DSM, DTM, contour line generation and editing from stereo images with viewing and editing tools
- Shall support aerial photo (frame, line scanning) and UAV image processing (dense image matching)
- Able to customize the accuracy for each Level above
- The processing system shall support both GUI and command line (the former is preferred) and may include a next generation visualisation system (3D/VR/4D etc.).

4.6 Mobile Ground Segment

- A replication of the downlink and processing system suitable for embedding as a mobile system or located on a sea vessel.

5 Downstream

5.1 Distributed architecture

- The User Facilities are specific implementations of secondary processing facilities to be located at user sites (government departments, provincial authorities, academic institutions etc), and will incorporate both centralised data from GISTDA (imagery, applications and products) and other specific sources such as aerial, in-situ etc. and may include bespoke software developments.

5.2 User segment developments

- Bidders are invited to suggest user facility implementations and applications and products for specific areas of user needs.
- The bidder shall specify a development plan with costing including



- Design and user iteration⁶,
- Hardware/software implementation,
- COTS , existing applications and products and customization needed,
- Resourcing,
- Implementation plan including installation, verification, support and training.
- The SKP shall serve as the base for the user facility design and development and the bidder shall define how the resourcing in Thailand shall be performed and the level of personnel from the bidder company to be based in Thailand.

5.3 Catalogue user interface system

Provide customized front-end and back-end user interface systems with at least the following:

5.3.1 Front-end

- Support Web Map Tile Service (WMTS) and be able to display base map serviced by GISTDA or that from other WMTS systems
- Support image ordering for all satellites serviced by GISTDA such as THEOS (Thaichote), Thachote-2, Small Satellite, SPOT-2, SPOT-4, SPOT-5, SPOT-6, Landsat-5, Landsat-7, Landsat-8, Ikonos, GeoEye, QuickBird, WorldView-1, WorldView-2, WorldView-3, RapidEye, Radarsat-1, Radarsat-2 and can be modified (locally) to support other future satellites
- Include basic map layers such as Thailand boundary, administrative boundary (province, district, sub-district), rivers and waterways, main roads, important roads (e.g. 1-digit, 2-digit roads)
- Outside Thailand, provide country boundary with capital city name and location
- Able to display satellite imagery (geometric corrected) quick look on top of the base map
- Able to browse image by the following search conditions:

⁶ The user iteration is to detail with the users the functionalities and procedures for the user facilities - as part of the design process.

Instructions to Bidders

- resolution or satellite
- imaging time
- percentage of cloud
- sensor, imaging mode, angle
- area of interest by location, coordinates (UTM, latitude/longitude (degree), latitude/longitude (decimal)), administrative area (province, district, sub-district), an area designated by a point and radius (km)
- Able to import and overlay shape files (.shp, .shx, .dbf)
- Able to export the searched results in html, kmz, kml, shap files and quick look
- Support measure distance (metric scale) on a map, measuring distance between points, coverage area calculation
- Include map tools / functionality such as zoom, pan, drawing tool for rectangle, polygon, area deletion, area trim
- Support user account management and online order tracking
- Menu selection by mouse-clicking
- Support new image ordering with at least the following customization:
 - Able to input user profile and necessary information for service and costing
 - Include the searched results in the quotation form
 - Display the order by satellite, scenes, or area with cost
 - Able to calculate the number of scene needed to cover an area of interest (only for Thaichote, Thaichote-2, Small Satellite)
 - Able to export the searched results and order to spreadsheet
- Provide users login report by frequency (total, daily), user type (local, international), login time, login duration
- Minimum 3 years guarantee (software and hardware) after delivery

5.3.2 Back-end

Instructions to Bidders

- Browse purchase order by date (day, month, year)
- Browse image order by satellite serviced by GISTDA such as THEOS (Thaichote), Thachote-2, Small Satellite, SPOT-2, SPOT-4, SPOT-5, Landsat-5, Landsat-7, Landsat-8, Ikonos, GeoEye, QuickBird, WorldView1, WorldView2, WorldView3, RapidEye, Radarsat-1, Radarsat-2 and can be modified (locally) to include other future satellites
- Brose purchase order by time
- Generate quotation and send quotation, with the quick look of the selected image, by mail providing links for order confirmation and order tracking (both in Thai and English)
- Generate and view ordering summary and export to files
- Able to record and export shape files
- User account management and logging with customized access / right
- Price customization with at least two categories: standard price and reduced price
- Able to interact with the Image Ground Segment system, e.g. in form of XML files, to transfer order / track order (pending, completed, QC-failed, etc.)
- Minimum 3 years guarantee (software and hardware) after delivery

6 Dual-use operation

Thaichote-2 shall be able to support dual-use operation. In this case, satellite control and operations shall be performed and responsible exclusively by GISTDA, whereas the acquisition planning and image processing system shall be separable and operable through dual user's terminal. Requirements and details for dual-use operation are as follows:

- CGS-MPC shall comprise of, at least, two acquisition planning terminal, one is for GISTDA (GPT), another is dedicated to military/defense. The Military User's Terminal (MUT) shall be separated physically and shall be installable at different location with dedicated secure connection to the MPC system.
- MUT shall operate as an integrated user's interface for military operations. It shall be able to task Thaichote-2 and display/export Thaichote-2 products from MIPS.

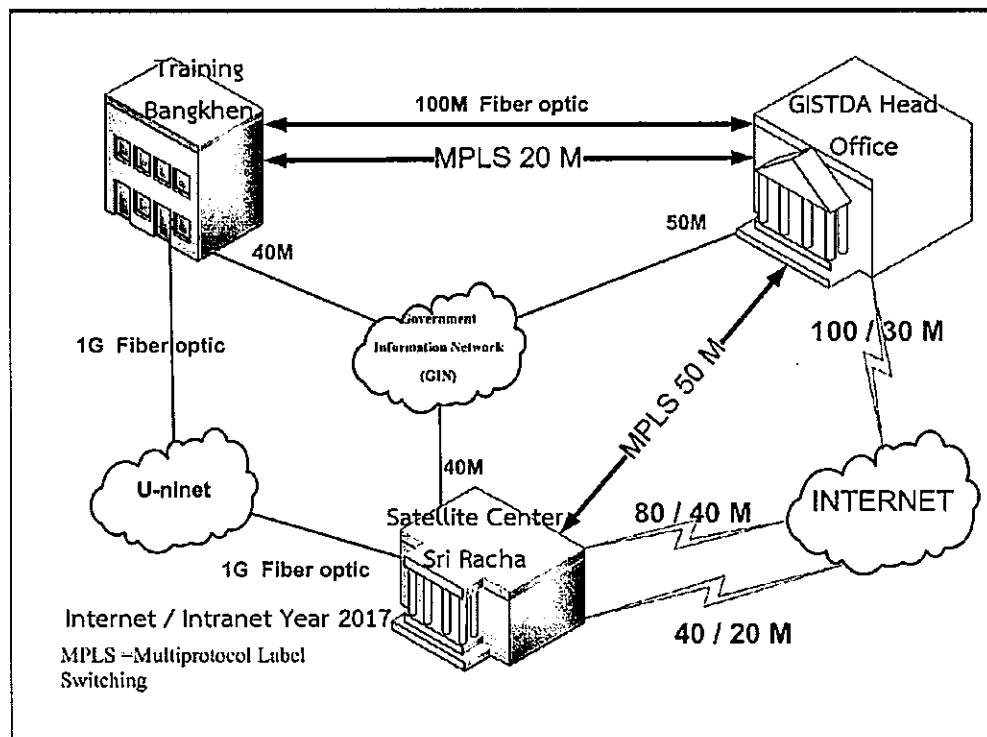
Instructions to Bidders

- MUT shall comprise of dedicated archiving system to store the processed imagery from MIPS.
- MPC shall be able to manually/automatically plan and schedule the requests ingested from MUT and GPT according to predefined rules, constraints, priority levels and satellite usage optimization criteria. The rules and constraints should also be modifiable.
- IGS shall comprise of two parallel image processing system, one is dedicated to GISTDA (GIPS) and another is for military (MIPS). Both systems will be physically installed at separate secure location inside GISTDA ground control station. MIPS and GIPS shall contain its own de-ciphering module and process the downlinked data exclusively according to the corresponding ciphering key subject to each particular acquisition.
- MUT shall allow the users to connect and operate remotely via secure connection.

APPENDIX 6:REQUIREMENTS FOR IT INFRASTRUCTURE DESIGN

The bidder shall study the schematic of the current IT infrastructure of Thailand as shown below and shall design, according to the proposed solutions/applications and data requirement of THEOS-2, the proper IT infrastructure for linking data between the following organizations:

Connections	Link
GISTDA – Ministry of Agriculture and Cooperative	Direct via Government Information Network (GIN)
GISTDA – Ministry of Information and Communication Technology	Direct via Government Information Network (GIN)
GISTDA – Ministry of Interior	Direct via Government Information Network (GIN)
GISTDA – Ministry of Science and Technology	Direct via Government Information Network (GIN)
GISTDA - Ministry of Defence	Direct via Government Information Network (GIN) and direct with dual link architecture
GISTDA - Ministry of Natural Resources and Environment	Direct via Government Information Network (GIN)
GISTDA – Other Ministries	Direct via Government Information Network (GIN)
GISTDA – Education network	Direct with dual link architecture



Instructions to Bidders

The requirements on the IT infrastructure

- The bidder shall provide the number of users in each group for each level
 - Management Level
 - Administrator Level
 - Users Level
 - Publish Level
- The bidder shall provide the Services Level Agreement which can be used to supports the operation throughout 24 hours and 7 days.

APPENDIX 7: REQUIREMENTS FOR CAPACITY BUILDING & TECHNOLOGY TRANSFER, AND TRAINING

1 Capacity Building and Technology Transfer

The bidder shall provide the full technology transfer for Thai engineer/scientist on hand-on working in each system/subsystem development of whole value chain; upstream (space segment), midstream (ground segment), and downstream (geo-information application and solution). The full technology transfers shall consist of subjects, procedure and number of Thai engineers and trainees. Bidder shall provide the extensive working plan for each position and function (refer to Table 1 to Table 3) throughout the program duration, under close supervision of professionals/mentors.

1.1 Space Segment

The role, responsibility and number of staff for space segment development are listed in Table 1.

Table 1 Space Segment Team:

No.	Role/ Function	Qualification/ Education	Number (persons)		Responsibility
			Main Satellite (abroad)	Small Satellite + Engineering Model (at SKP)	
1	Project Manager	Engineering/project management	1	1	Satellite project management
2	Project Quality Assurance	Engineering/project management and quality assurance /assessment	1 (including Procurement Management)	1	Project Quality Assurance/Assessment
3	SE : System Engineer	Satellite Engineering / Mechanical & Electrical Engineering	2 (including launch management)	1	Supervise all sub-system technical aspects / design / manufacture / assemble / integration / test / launch
4	Mechanical / structure/AIT engineer	Mechanical Engineering/ Thermal Engineering	2	2	- Perform structure design and analysis, thermal control assessment - Implementing and supervise the assemble, integration and test both



Instructions to Bidders

No.	Role/ Function	Qualification/ Education	Number (persons)		Responsibility
			Main Satellite (abroad)	Small Satellite + Engineering Model (at SKP)	
					in subsystem level and satellite level including the environment test
5	Payload / instrument engineer	Mechanical Engineering / Applied Physics: optical / Electrical Engineering / Computer Engineering	3	5	Design and develop 1) Camera system (alignment, thermal control, mechanical assembly) 2) optical sensor 3) Electronics and processing (hardware and software) 4) High speed image processing and algorithms 5) I&T (integrate and test)
6	On-Board Data Handling (OBDH) engineer	Computer Engineering / Electrical Engineering	2	3	1) Design and develop the OBDH 2) Design and develop embedded system for Telemetry and Telecommand 3) I&T (integrate and test)
7	Flight software engineer	Computer Engineering / Electrical Engineering	2	3	Design and develop flight operating system 1) Data handling and Communication 2) Sensing, monitoring and control 3) I&T SW (integrate and test) with the flight platform
8	TT&C engineer	Electrical Engineering, RF engineering	2	3	Design and develop RF receiver and transmitter at S and X band

Instructions to Bidders

No.	Role/ Function	Qualification/ Education	Number (persons)		Responsibility
			Main Satellite (abroad)	Small Satellite + Engineering Model (at SKP)	
					I&T (integrate and test)
9	Power system engineer	Electrical Engineering	2	2	Design and develop power control distribution unit (PCDU) interworking with solar cells and battery for satellite subsystem power, I&T (integrate and test)
10	AODCS engineer AODCS : Attitude-Orbit Determination and Control System	Electrical Engineering / Mechanical Engineering	2	3	Design and develop electronics subsystems for interfacing and control 1) AODCS sensors (sun sensor, magnetometer, gyro, star tracker) 2) AODCS actuators (reaction wheel, magneto-torquer, Control Moment Gyroscope, propulsion system) 3) I&T (integrate and test)
11	Flight dynamic engineer	Electrical Engineering / Mechanical Engineering / Applied Physics: flight dynamic	2	2	Design and develop algorithm for 1) Flight dynamic and orbit control 2) Attitude control 3) I&T SW (integrate and test)
12	End to end engineer (space segment to ground segment)	Electrical Engineering / Computer Engineering	-	3	Design and develop end to end testing system I&T (integrate and test)
13	EGSE development engineer	Electrical Engineering / Computer	-	3	Design and develop EGSE for testing small satellite

Instructions to Bidders

No.	Role/ Function	Qualification/ Education	Number (persons)		Responsibility
			Main Satellite (abroad)	Small Satellite + Engineering Model (at SKP)	
		Engineering			
14	Component procurement engineer	Electrical Engineering / Industrial Engineering	-	2	Managing Satellite component or subsystem procurement
15	Launch engineer	Mechanical Engineering	-	2	Launch coordination and planning
16	Technician and engineer supporting sub-system productions	Electrical / Mechanical Computer / Engineering /	-	5	Subsystem production according to the design
		Total (persons)	21	41	

1.1.1 Technology Transfer of Main Satellite Development

The bidder shall provide full technology transfer of satellite and VHR (Very High Resolution) optical payload developments to Thai engineers. The bidder shall clarify the restrictions under ITAR (International Trafficking in Arms Regulations) and EAR (Export Administration Restrictions) (if any).

The bidder shall elaborate, with reference, the analysis and methodology of utilizing imagery from the proposed VHR satellite to create the map of 1:4000 scale (orthorectified).

1.1.2 Technology Transfer of Small Satellite Development

- **Small Satellite**

Bidder shall arrange and provide full technology transfer via designing and building one small satellite (50 - 100 kg.) in Thailand (design, procuring components, assembly, test, and the following item appeared in the Heading 2 (Small Satellite) of Appendix 5) ; aiming to enhance the competency of the country and develop the related domestic industry in order to produce and export satellite parts and components or the whole satellite in the future.

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Instructions to Bidders

Bidder shall provide full technology transfer and development of EGSE (Electrical Ground Support Equipment) for testing the developed small satellite. The role of EGSE shall include (at least)

- satellite test and operation scenario
 - automatic AODCS execution to control and monitor satellite by sending commands and receiving telemetry, storing and retrieving all data
 - communication equipment for sending commands and receiving telemetry via RF or hard wire
 - power management equipment in order to supply power to satellite and control/monitor the power related status, includes solar array simulation
- **Engineering Model (includes primary and secondary payload)**

Bidder shall provide an Engineering Model (EM) which can be tested and function similar to the in-orbit satellite. This EM will be used for testing, operation and development and will be installed in the laboratory. The EM therefore will not require space-grade components. The engineering model shall be developed and integrated in Thailand. Commercial grade components which are available in Thailand shall be considered wherever technically feasible.

- **Assembly Integration and Test (AIT) Facilities**

Bidder shall provide a management plan including test equipment needed for Assembly Integration & Test (excluding test facilities such as cleanroom, shaker, thermal vacuum chamber, etc.) supporting research and development of the upstream in Thailand. The plan shall cover an implementation period of not less than 5 years starting from the effective project starting date. It will cover education, research and development and standardized assembly, integration and test. It shall be able to ensure that the developed upstream system will function according to the design. Furthermore, the operation plan shall be flexible to cope with uncertainties, such as reallocation of budget, overdue, changes of design or requirements during the project procedures.

The plan shall identify system requirements, required AIT equipments, budget (investment and operation costs), human resources (number, required expertise and

additional trainings) including the payload technology development. Each individual work plan shall be divided in phases. Milestones shall be provided.

- **Satellite Simulator**

Bidder shall arrange and provide full technology transfer and development of Satellite Simulator following the requirements in Heading 2.6 of Appendix 5. The hand-on development includes

- Architectural Designing
- System monitoring & control:
 - Observation of simulation variables
 - Introduction of stimuli, events, and patches to simulation variables
- Model development & deployment lifecycle
- External interfacing
 - Connection to Satellite Control System
 - Automated simulation control
- System management: installation, upgrade, & maintenance

1.2 Ground Segment

The role, responsibility and number of staff for ground segment development are listed in Table 2.

Table 2. Ground Segment Team: Ground Control and Data Receiving System, Mission Planning System, Production System, Archiving System and Data Service System

No.	Role/ Function	Qualification/ Education	Responsibility	Number (persons)
1	Ground System Manager	Engineering or Science or Information Technology	Overall ground segment management	1
2	Ground System Engineer		Technical Ground segment	1
3	Satellite Control and Data Reception engineer		Design and develop Satellite Control and Data Reception System	2

Instructions to Bidders

No.	Role/ Function	Qualification/ Education	Responsibility	Number (persons)
4	Mission Planning System		Design and develop Mission Planning System	2
5	Engineer/ Data Production System		Design and develop Data Production System	2
6	Engineer/ Archiving System		Design and Develop Archiving System	2
7	Engineer/ Data Service System		Design and develop Satellite Data Service System	2
8	Cal/Val Engineer		Calibration and Validation	2
			Total (persons)	14

Bidder shall arrange and provide full technology transfer via designing and building of THEOS-2 ground segment, following items in the heading 4 (Midstream) of Appendix 5.

1.3 Geo-Informatics Applications/Solutions

The role, responsibility and number of staff for Geo-Informatics Applications/Solutions development are listed in Table 3.

Table 3. Geo-Informatics Team:

No.	Role/ Function	Qualification/ Education	Responsibility	Number (persons)
1	Applied Geo-Informatics Manager	Engineering or Science or Information Technology or GIS	Direct and overall management of Applied Geo-Informatics Systems	1
2	Engineer/ Scientist		Solution System Development	10
3	Engineer/ Scientist		Design and develop Integrated Water Management	5
4	Engineer/ Scientist		Design and develop Disaster and Geo-Hazard	5

GISDA

Instructions to Bidders

No.	Role/ Function	Qualification/ Education	Responsibility	Number (persons)
5	Engineer/ Scientist		Design and develop Agriculture and Food Security	5
6	Engineer/ Scientist		Design and develop Natural Resources and Eco-System	5
7	Engineer/ Scientist		Design and develop Urban, Economic Corridor Planning and Infrastructure-Augmented Reality	5
8	Engineer/ Scientist		Design and develop Social Wellness and National Security	5
			Total (persons)	41

Bidder shall arrange and provide full technology transfer via designing and building of THEOS-2 Geo-Informatics Solutions and Application as appeared in Appendix 3.

1.4 Fundamental Courses

The bidder shall provide the fundamental courses for Thai engineer/scientist before hand-on working. The core courses (at least) are listed as follows:

- Upstream Segment
 - Satellite System Engineering

Orbital Dynamics and Mission Analysis, Launch System, Space Environment, Satellite Structure, Electrical and Power System, Satellite Tracking, Monitoring and Control, Thermal Control System, Attitude and Orbit Control Systems, Propulsion Systems, Data Handling Systems and Ground Systems

- Satellite System Applications

Earth Observation Systems, Remote Sensing Systems (Optical and SARs), Distance, Velocity and Altitude Measurement System, SAR and Microwave

Instructions to Bidders

Imaging Techniques, Satellite Image Data Analysis, Satellite Navigation, Interplanetary Observation

- Midstream and Downstream Segments
 - Remote Sensing via Satellite

Electromagnetic Wave Radiation, Interaction of Electromagnetic Wave with respects to observing surfaces, Dispersion and Absorption of Electromagnetic Wave in the atmosphere, Remote Sensing in visible and microwave spectrum, Satellite and Orbits for Remote Sensing Application, Sensors Classification and Comparisons, Satellite Image Data Processing, Satellite Image Data Geometric and Radiometric Correction, Satellite Image Data Interpretation, Image Data Applications on Natural Resources and Geology Exploration, Atmospheric Monitoring and Geo-Informatics Systems

- Area Based Analysis and Model Simulation

Area Based Analysis and Simulation in Geo-Informatics Systems from the study of Area Based Models, Area Based Data Classifications and Interpretations, Geo-reference Coordinates Transformation, Area Based Data Interpolation and Extrapolation, Area Based Algorithms, Principle of Statistics, Area Based Statistics, Map Formulation and Analysis, Map Mosaic Techniques, Area, Perimeter and Distance Calculation

- Geo-Informatics System Management and Implementation

Studying on Principle of Geo-Informatics Systems, Management and Implementations includes planning and analysis of requirements, system design and subsystems development and system operations

Management includes study of implementation process management, implementation planning, budget analysis and result assessment, operation management and related laws and regulations

1.5 Project Management and Assessment

The bidder shall provide the advisory and consultancy on Project Management and Assessment to Thai Team. The content shall covers

The logo for GISTDA (Geospatial Information Science and Technology Development Agency of Thailand) is displayed in a stylized, handwritten-like font.

Instructions to Bidders

- Management during project development phases in various aspects including project scope, schedule, budget, expense, contractual management, procurement management, project output, human resources, project control, monitoring and assessment, key performance index, project implementation approaches in form of design and implementation
- Management during operation phase focusing on integration of upstream, midstream, downstream and industrial sectors
- Risk assessment and backup plan, risk probability and gravity, risk analysis and management on various aspects such as budget and expense, project structure and implementation, risks on technology and personnel, launch failure, in-orbit failure, over-budget, project delay and risk from policy's change
- Approaches and procedures of project assessment on both value and worthiness before, during and after project's implementation

1.6 Document/Material for Capacity Building and Technology Transfer

The bidder shall provide the document of technology transfer for space segment development, ground segment development, and geo-informatics application and solution implementation. In addition, the materials of fundamental courses shall be provided.

For the development/implementation of each subsystem/system, the set of documents shall be provided as listed as follows (at least)

- mission or subsystem/system requirement and analysis
- preliminary design review (PDR)
- detail design review (SDDR)
- interface control review (ICR) or interface control design review (ICDR) or interface control document (ICD)
- critical design review (CDR)
- AIT procedure
- environment testing or field testing procedure
- LEOP (launch and early orbit phase) and Commissioning Phase procedure

Bidder shall propose the terms and conditions of capacity building and technology transferring including

Blueprint / Block Diagram / System & Circuit Schematic / Circuit Design / Firmware / Development Kit / API on both Hardware and Software (SDK) of system, sub-system and all components / Technical Documents and Manuals, Datasheet, Application Notes / Licenses which allow the use of Schematic / Design / Firmware / Development Kit /API as mentioned above, to design, and develop such technology in the future.

2 Training

2.1 Downstream

The application development for downstream application systems comprises of various tasks which required skills and expertise. These tasks include

- Design and development of system and tools for integrating, processing, improving, analyzing, displaying and exchanging of geo-informatics data
- Survey and observation using remote sensing techniques
- High level skills on GIS application software for collecting data, importing data, analyzing and displaying spatial data
- Database design and development
- Programming and coding
- Data structure design and data processing algorithm design
- Data quality validation
- Data exchange and distribution
- Multidisciplinary problem solving by using GIS
- Automatic data processing
- Systematic correction on radiometric, geometric, ortho-rectification and image quality enhancement

Instructions to Bidders

- Mapping and cartography
- Satellite image classification by both operator and system
- Satellite image interpretation
- GIS database development
- Development of software for value added GI product.

Bidder shall provide the training plan which covers at least 1,000 people from all related organizations.

2.2 Midstream

Midstream consist of satellite (including the proposed constellation) data receiving and processing system, standard GI production, central catalog system, data archiving system, and data processing system on both air-based and ground-based sensors. Accordingly, Bid shall provide at least, the training activities as follows:

- Acquisition system and data archiving system development for satellites in the framework of THEOS-2 system (Primary/Second/Constellation Satellites). The activities shall focus on training minimum of 35 people on the design and development of the related hardware and software.
- Development of standard and value-added production system for satellites in the framework of THEOS-2 system. The activities shall focus on training minimum of 30 people on the design and development of the related hardware and software.
- Data service system development for satellites in the framework of THEOS-2 system. The activities shall focus on training minimum of 25 people on the design and development of the related hardware and software
- Satellite image quality improvement and image correction for satellites in the framework of THEOS-2 system. The activities shall focus on training minimum of 10 people on the design and development of the related hardware and software.
- Personnel preparation (minimum 200 people) for processing and management of value-added products, i.e. data interpretation for ready-to-use products, downstream classification for input data of downstream system, change detection etc., in order to support operations of Ministry of Agriculture and Cooperatives, Ministry of Information and Communication Technology, Ministry of Natural

Resources and Environment, Ministry of Science and Technology, Ministry of Defense and Ministry of Interior.

2.3 Upstream

Upstream consist of a very high resolution satellite and its ground control system, a constellation of satellites, a small satellite, and a satellite engineering model, which Bidder shall propose training activities as follows:

- Training on monitoring system and data collection system
- Training on the system operation
- Bid shall study business and/or industries related to the upstream section and provide information on type and its market capital, such as the business related to the manufacturing of solar cell/battery/memory and storage, electronic devices for aviation and aerospace industry, tracking and navigation devices, and the one related to research and development such as material science, engineering and medical sciences.
- Other proposals related to the capacity building for personnel on space technology support such as Special Economic Zone, related law and regulations, i.e. space law, ITAR, ITU, and satellite launch Insurance.

3 Technology Transfer and Training Mechanism

Bidder shall provide technology and knowledge transfer such as Data interpretation and applications utilizing data from various sources, trainings/seminars/site visits on the proposed technologies related to the project, GIS programming (image processing/pattern recognition/mobile application, validation and testing and Application Program Interfaces: APIs), Hands-on trainings on upstream, midstream and downstream. At the minimum, the contents shall cover

- Course details on knowledge transfer via theoretical sessions/trainings (short term and long term) for operational level, management level and policy making level
- Practical training details of the upstream, midstream and downstream for operation level, management level, and policy maker level
- Details on the industry involvement in upstream, midstream and downstream

- Scholarship for Master's degree and Ph.D. in the fields of Space Technology and Geo-Informatics and other fields related to THEOS-2 system development and its further developments

4 Capacity Building on Maintenance

Bidder shall provide maintenance service for upstream, midstream and downstream including details on capacity building so that Thailand can perform system maintenance by itself such as

4.1 System Maintenance

- Dedicated corrective maintenance due to systems design flaws, incorrect installation and validation
- At least three years of hardware warranty after the final system acceptance (system hand-over)
- Satellite in-orbit insurance for accident or unforeseen events such as collision with space debris/meteoroids and anomalies leading to disrupt, degrade or discontinue of operation
- At least three years of software warranty after the final system acceptance (system hand-over) including software patching/new version updating.

4.2 Capacity building on system maintenance carried by contractual parties.

- Feasibility study, analysis, drawings, schematics, blueprint, AIT handbooks, datasheet and procedure manuals that cover all hardware under THEOS-2 system from Prime Contractor to Sub-Contractors
- Feasibility study, analysis, installation, setup and testing procedure which are parts of the Software under THEOS-2 system from Prime Contractor to Sub-Contractors
- Delivered system (both Hardware and Software) under THEOS-2 system shall not be a closed system which prevent owner from maintenance and further development
- Feasibility study, evaluation, problems, obstructions, suggestion, and further approaches concerning to GIS capacity building for Decision Support System reformation and Area-based risk management

5 Research and Promoting SME in Space Industry for Satellite Parts Manufacturing or Subsystem Development

The logo of the Geological Survey of Thailand (GISTDA) is displayed, featuring a stylized, handwritten-style representation of the acronym 'GISTDA'.

Instructions to Bidders

Bidder shall propose space technology development models or mechanism to support and promote domestic entrepreneur in both hardware and application systems along the value chain (upstream, midstream and downstream). This will also include research that leads to capability building on space industry based on the Thailand's existing potential.

The upstream is not limited to manufacturing of satellite parts or developing satellite subsystems and ground station system, but also operational software that is used in satellite and ground station.

The midstream is not limited to the development of, partial or whole, satellite image data processing, standard product processing (from satellite imagery and other sensors), archive and data service system.

In the downstream, geo-informatics applications and decision-making and area-based management system are key components that the local industry can involve in both in the development phase and the testing phase. Thailand is also the geographical center of the region and has a variety of problems thus make it a suitable test site for the application systems development.

Bidder may propose other models or mechanism to promote domestic entrepreneur for the development of space industry in Thailand.

APPENDIX 8:REQUIREMENTS FOR BID PROGRAM

The following diagram gives an indicative schedule of the THEOS-2 program over a period of 15 years (5 years Project Implementation and 10 years Project Operation) as a guideline to the overall program.

The suppliers are invited to use this overview as an input to detail their own schedule of deliverables and system implementation.

In particular when deriving the schedule the supplier shall:

- Indicate the availability of datastreams / datasets from existing satellite or constellations to be offered,
- Indicate any early-start activities on midstream and downstream areas that would benefit from initiation at the start of the process, and provide a planning for the resources, development and implementation, together with financial estimates,
- Provide a detailed schedule for the development and implementation of the THEOS-2 program, including reviews, milestones, delivery dates, need dates, launch dates (in the case of satellite provision), acceptance and handover dates,
- The supplier shall specify the scope and success criteria of each of the reviews to be undertaken,
- The supplier shall specify any customer furnished equipment or facilities expected for the program and the need dates.

Instructions to Bidders

Component	Activity	Year 1		Year 2		Year 3		Year 4		Year 5	
1. Satellite system procurement and ground receiving system improvement	1.1 Constellation access	Satellite image procurement from satellite constellations									
	1.2 Main satellite	Staff prep.	Satellite design	Satellite subsystem mfg.		AIT		AIT		Cal	Val
	1.3 Small satellite	Staff preparation	Satellite design	Satellite subsystem mfg.		AIT		AIT			
	1.4 Launch of two satellites	Co-planning				Study launch technology					
	1.5 Ground receiving system improvement	Design	Improvement	Develop ground system for two satellites (multi-mission)		Test and operate		Test and operate			
	1.6 Ground receiving system for national security	Design	Develop ground system for national security agency		Test and operate		Test and operate				
2. Satellite image production and data service system development	2.1 Satellite image processing and standard imagery production system	Requirements consolidation	System design	System development		Test and operate		Test and operate			
	2.2 Archive, catalogue and users service system										
	2.3 Archive for national security										
3. Application systems development	3.1 Area-based decision making solution platform	System design		System development		Test and operate		Test and operate			
	3.2 Applications	System design		System development		Test and operate		Test and operate			
4. ICT infrastructure improvement	4.1 IT Infrastructure	Design	Procure and installation								
	4.2 Data link between archive system and national security system (GEONT/IMINT)	Design	Procure and installation								
	4.3 Data link with other non-satellite based sensors / systems	Design	Procure and installation								
5. Capacity building and	5.1 AIT Facility (Customer Furnished Item)	Building construction		Equipment procurement							

ISTDA

Instructions to Bidders

Component	Activity	Year 1			Year 2			Year 3			Year 4			Year 5		
technology transfer																
	5.2 Satellite Engineering Model	Partnership with local enterprises			Design			Development and production			Test			Operate / R&D		
	5.3 Human resources development through co-development of two satellites, one engineering model, GI applications and area-based decision making solution platform, practical and on-the-job trainings, short course, master's and doctoral degree programs	Personnel preparation for technology transfer covering the upstream, midstream and downstream parts			Technology transfer via hands-on trainings / short-term and middle-term trainings - Design and produce subsystem for the main satellite, a small satellite and an engineering model - Assembly and test of the main satellite, a small satellite and an engineering model - Launch technology - Ground system, image production and standard image production, archive and service systems - Application systems (7 sectors) - Area-based decision making solution platform (4 domains)											
	5.4 Research institutes and local enterprises with capability on satellite part production or satellite subsystem development	Research institution co-ordination	Local enterprise capacity building		Collaborate with local enterprise on satellite part production or satellite sub-system production			Elevating the local enterprises to the international space industry								

ELISTDA

APPENDIX 9: REQUIREMENTS FOR BUSINESS DEVELOPMENT

1 International Business Development

- Propose sales region outside Thailand
- Propose business model canvas for international business development
- Describe the marketing activities that the bidder proposes to use to develop demand for products and services within the proposed sales region;
- Describe the application development, other R&D, and technology transfer activities the bidder would be willing to commit to in order to increase data sales; and
- Propose activities and services that the bidder would be willing to commit to in order to provide a high level of customer satisfaction and support.

2 Business Performance and Objectives

- Describe the current business performance of the corporate entity including:
 - Annual turnover (in US dollars using current exchange rates as of the date of the proposal);
 - Annual marketing and sales budget;
 - Major clients; and
 - Percent of sales to different sectors (e.g. agriculture, land use planning, forestry, mineral/oil/gas exploration, environmental monitoring, base mapping, military, marine applications, etc.)
- Describe current public relations and advertising activities and provide examples of advertising materials and web sites.

3 Financial Aspects

- All proposals must clearly specify expectations in terms of product pricing, costs, expected volumes and the returns to GISTDA for reception rights and data sales. A minimum return to GISTDA must be committed to based on the assumption that the satellite will operate within specified standards. Failure to operate between these standards would result in a pro-rated expected return.
- GISTDA encourages innovative arrangements that will be mutually beneficial.

APPENDIX 10: EVALUATION AND CRITERIA

Evaluation & Scoring in Integrated Solutions (APPENDIX 3)

No	Description	Total Score (40)	(6) Core Product Requirements	(7) Explicit Solution Specification Requirements					(7.6) Urban, Economic Corridor Planning & Infrastructure-Augmented Reality
				(7.1) Agriculture & Food Security	(7.2) Integrated Water Management	(7.3) Disaster & Geo-Hazard	(7.4) Natural Resources & Ecosystem	(7.5) Social Wellness & National Security	
1	Bid Conformance	1							
2	Relevant Experiences	7							
	2.1 Firms								
	2.2 Consortiums								
	2.3 Technical Personnel								
	•Local								
	•Expatriate								
3	Technical Proposal								
	3.1 Approach	5							
	•Technology & Application								
	•Architecture & Design								
	3.2 Methodology & Deliverables	12							
	•Mapping (4D), Measuring & Monitoring								
	•Modeling								
	•Managing								
	3.3 Data Source / Data Compilation	6							
	•RS/GIS								
	•In-Situ/Ground								
	•Review								



[illegible]

No	Description	Total Score (60)	Core Requirements	issue					Training
				Main Satellite	Small Satellite	Ground Segment	Dual Use	Capacity Building and Technology Transfer	
1	Bid Conformance (2)	2							
2	Relevant Experiences (3)								
	2.1 Firms	1							
	2.2 Consortiums	1							
	2.3 Technical Personnel	1							
3	Technical Proposal								
	3.1 Main Satellite (17)			Obit Design	Primary Payload	Image Quality	Satellite Platform	Satellite Performance	Launching
	• Technology (Architecture & Design)	9							
	• Knowledge Transfer	4							
	• Hardware & Software	2							

Instructions to Bidders

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APPENDIX 11: REFERENCE INFORMATION

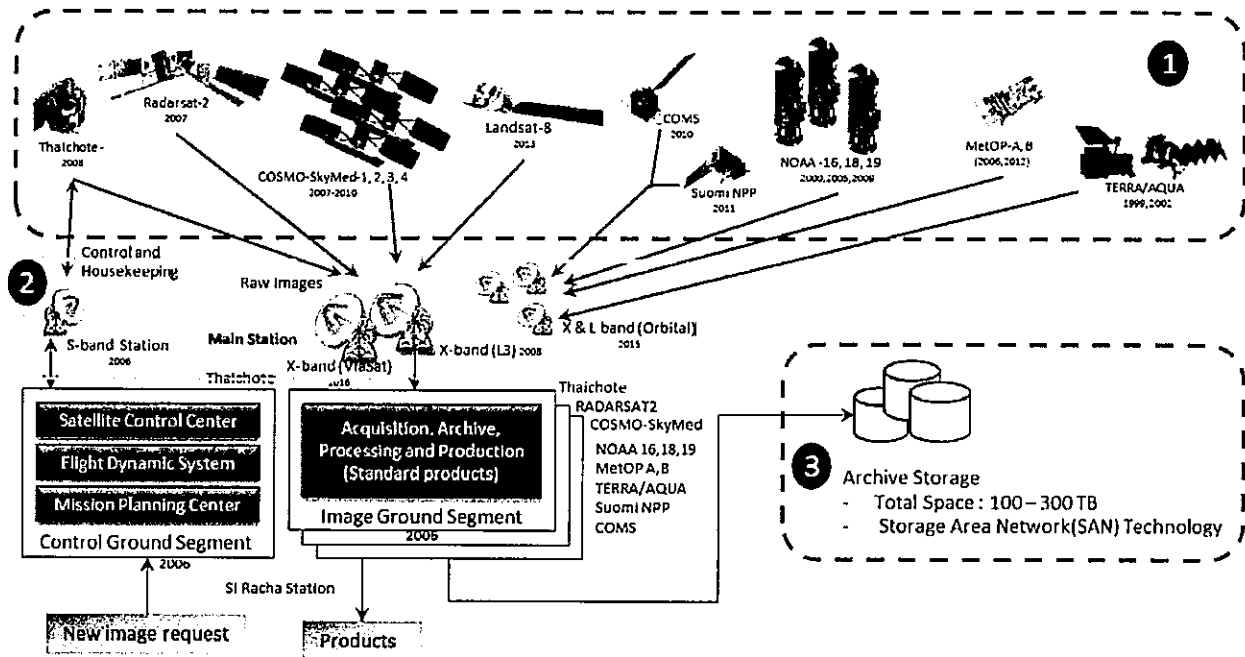
1 Country Strategy & Policy Papers (attached as a separate document)

1.1 20-year National Strategic Action Plan (2017-2036)

1.2 12th National Economic and Social Development Plan

2 Existing systems

2.1 Hardware at SKP



2.2 List of Earth Observation Satellites (the ones which their data is downlinked at SKP)

Satellite	Payloads/Instruments	Uplink Frequency	Downlink Frequency	Orbit
THEOS (THAICHOTE)	- PAN (B&W) 2m. GSD - Multispectral (R,G,B, NIR) 15m. GSD	2.035-2.2 GHz	8 GHz	SSO - 822
RADARSAT-2	C-Band 5.405 GHz (3/8/18/25/30/50/100 m)	N/A	8 GHz	SSO-798 km
COSMO-SKYMED I-IV	X-Band	N/A	8 GHz	SSO- 619km
LANDSAT-VIII	- OLI (8 bands) 0.43-1.38 μm @ 30 m GSD - TIRS (2 Bands) 10.6-12.51 μm @ 100 m GSD	N/A	8 GHz	705 km
NOAA	Advanced Very High Resolution Radiometer (AVHRR/3)	N/A	1.6-1.7 GHz	SSO - 833km

Instructions to Bidders

TERRA/Aqua (MODIS)	250 m (bands 1-2), 500 m (bands 3-7), 1000 m (bands 8-36) wavelength from 0.4 μ m to 14.4 μ m	N/A	8 GHz	SSO - 705 km
SUOMI NPP	Visible Infrared Imager (22 Bands) + others	N/A	8.215 GHz	SSO-824 km
COMS	Multispectral (8-band) VIS/NIR data	N/A	1.6-1.7 GHz	GEO – 36,000 km

2.3 Lists of Antenna and Front End Equipment available for current and future data acquisition

2.3.1 Antenna systems

- 13.56m X-Band Antenna (VIASAT) : in operation since 2016 for THEOS/RADARSAT-2/LANDSAT-VIII and COMSO-SkyMed

X-Band Frequency Range	8.0 to 8.5 GHz
Polarization X-Band Data Channel	RHCP and LHCP
System G/T	37 dB/°K Clear Sky @ 5° Elevation Angle
IF Output	720MHz
S-Band Frequency Range	2.2 to 2.3 GHz
Polarization	RHCP / LHCP (Switch Selectable)
System G/T	20 dB/°K Clear Sky @ 5° Elevation Angle

- 13.56m X-Band Antenna (L3 Communications) : in operation since 2008 THEOS/RADARSAT-2/LANDSAT-VIII and COMSO-SkyMed

X-Band Frequency Range	8.0 to 8.4 GHz
Polarization	RHCP / LHCP (Switch Selectable)
System G/T	37 dB/°K Clear Sky @ 5° Elevation Angle 15°C
IF Output	720MHz
S-Band Frequency Range	2200 to 2400 MHz
Polarization	RHCP / LHCP (Switch Selectable)
System G/T	23 dB/°K Clear Sky @ 5° Elevation Angle

Instructions to Bidders

- 4.5 m S-Band Antenna (INDRA) : in operation since 2008 for THEOS TM/TC
 - Performance

PERFORMANCES SUMMARY		
#	PARAMETER	CHARACTERISTICS
1	Main antenna diameter	4.5-meter high efficiency system with S band capabilities
TT&C STATION PERFORMANCE		
2	Antenna configuration	Prime focus feed configuration with simultaneous and transmission capabilities
3	Operating frequency range	Transmission: 2025-2120 MHz, 2035.9625 MHz nominal Reception: 2200-2300 MHz, 2211 MHz nominal
4	Polarization	Transmission: selectable RHCP or LHCP Reception: simultaneous RHCP or LHCP
5	G/T at clear sky conditions within the Rx frequency range and Program Track case	> 10.0 dB/K for > 5° elevation @ 2200 MHz, and clear sky conditions
6	Axial ratio (Transmission & Reception)	≤ 2 dB
7	EIRP within the Tx frequency range	≥ 50 dBW
8	EIRP Control	20 dB minimum, 1 dB step

Table 3-1 Performances summary table

- Satellite interfaces

3.4.1.1.1 TM reception

	PARAMETER	CHARACTERISTIC
1	Frequency band (S-Band)	2211 MHz nominal
2	Signal Type	TM
3	Polarization	Polarization diversity RHCP and LHCP
4	Signal Modulation	BPSK + Scrambling +RS(interleave 5)
5	Total IPDF for 400 kb/s bit rate	-124.3 dBW/m ² to -144.3 dBW/m ²

Table 3-2 TM reception external interface

3.4.1.1.2 TC transmission

PARAMETER		CHARACTERISTIC
1	Frequency band (S-Band)	2035.9625 MHz nominal
2	Signal Type	TC
3	Polarization	Polarization selectable: RHCP or LHCP
4	Signal Modulation	PCM (NRZ-L) / BPSK / PM
5	EIRP	Higher than 50 dBW

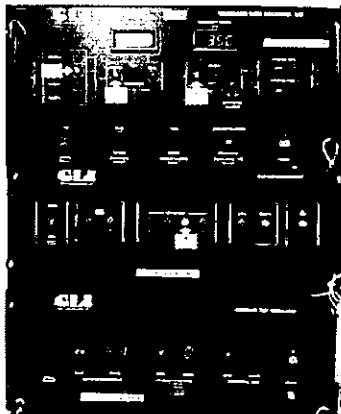
Table 3-3 TC transmission internal interface

- 2.4m L/X Band Tracking Antenna (ORBITAL) : in operation since 2015 for NOAA and TERRA/AQUA (MODIS)
- 3.6m L Band Non-Tracking Antenna (ORBITAL) : in operation since 2015 for COMMS

2.3.2 Demodulators

- Demodulator: Gray Lab

GRAY LABORATORIES, INC. HDRM for Radarsat-2



- BPSK, QPSK/OQPSK/AQPSK/UQPSK
- Fixed bitrate at 105 Mbps for Radarsat-2 and 120 Mbps for Thaichote
- Unprogrammable
- Impedance = 50 Ohm
- Output: I and Q or I+Q outputs on the rear panel

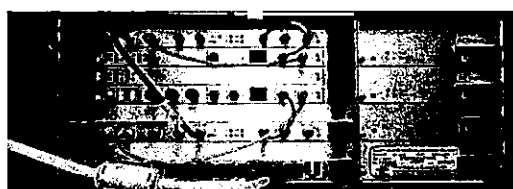
- Demodulator: VIASAT VHR-1200 (THEOS, LANDSAT-VIII, Radarsat-II)

Table 1-1 Data Rates per Modulation for Dual-Channel and Quad-Channel Modes

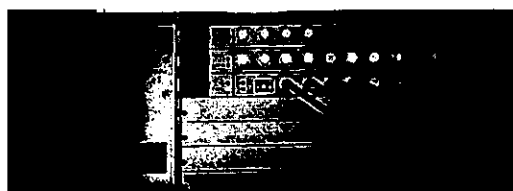
Modulation Format	Quad-Channel Mode 2x demodulators per IF channel	Dual-Channel Mode 1x demodulator per IF channel
Binary Phase Shift Keying (BPSK)	200Mbps x 2 demods x 2 IF channels (800 Mbps total)	400Mbps x 2 IF channel (800 Mbps total)
Quadrature Phase Shift Keying (QPSK)	400Mbps x 2 demods x 2 IF channels (1600Mbps total)	800Mbps x 2 IF channels (1600 Mbps total)
Offset Quadrature Phase Shift Keying (OQPSK)		
8 Phase Shift Keying (8PSK)	600Mbps x 2 demods x 2 IF channels (2400Mbps total)	1200Mbps x 2 IF channels (2400Mbps total)

- Demodulator: RT Logic

RT logic (Avtec) HDRM for Landsat-8



front



rear

Receiver Specifications

- IF input : 2 selectable IF inputs
- IF frequency : 370 MHz, 720 MHz or 1.2 GHz
- IF bandwidth : 650 MHz
- IF impedance : 50 Ohms
- BPSK modulation up to 400 Mbps
- QPSK/SQPSK/AQOSK/UQPSK modulation up to 800 Mbps
- 8-PSK up to 1.7 Gbps
- Dynamic range : > 40dB

High-Speed front-End Processing

- Data rates up to 1.7 Gbps
- Viterbi decoding, differential decoding, frame synchronization, derandomization, LDPC, TPC, Reed-Solomon decoding and CRC decoding
- Time tagging and data quality annotation
- CCSDS virtual channel sorting with support for VCD

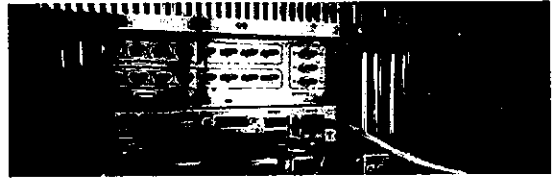
- Demodulator: Cortex

Cortex-HDRM for THAICHOTE and Cosmo-Skymed



Operating Mode 1 (mono demodulator @ 720 MHz IF input)

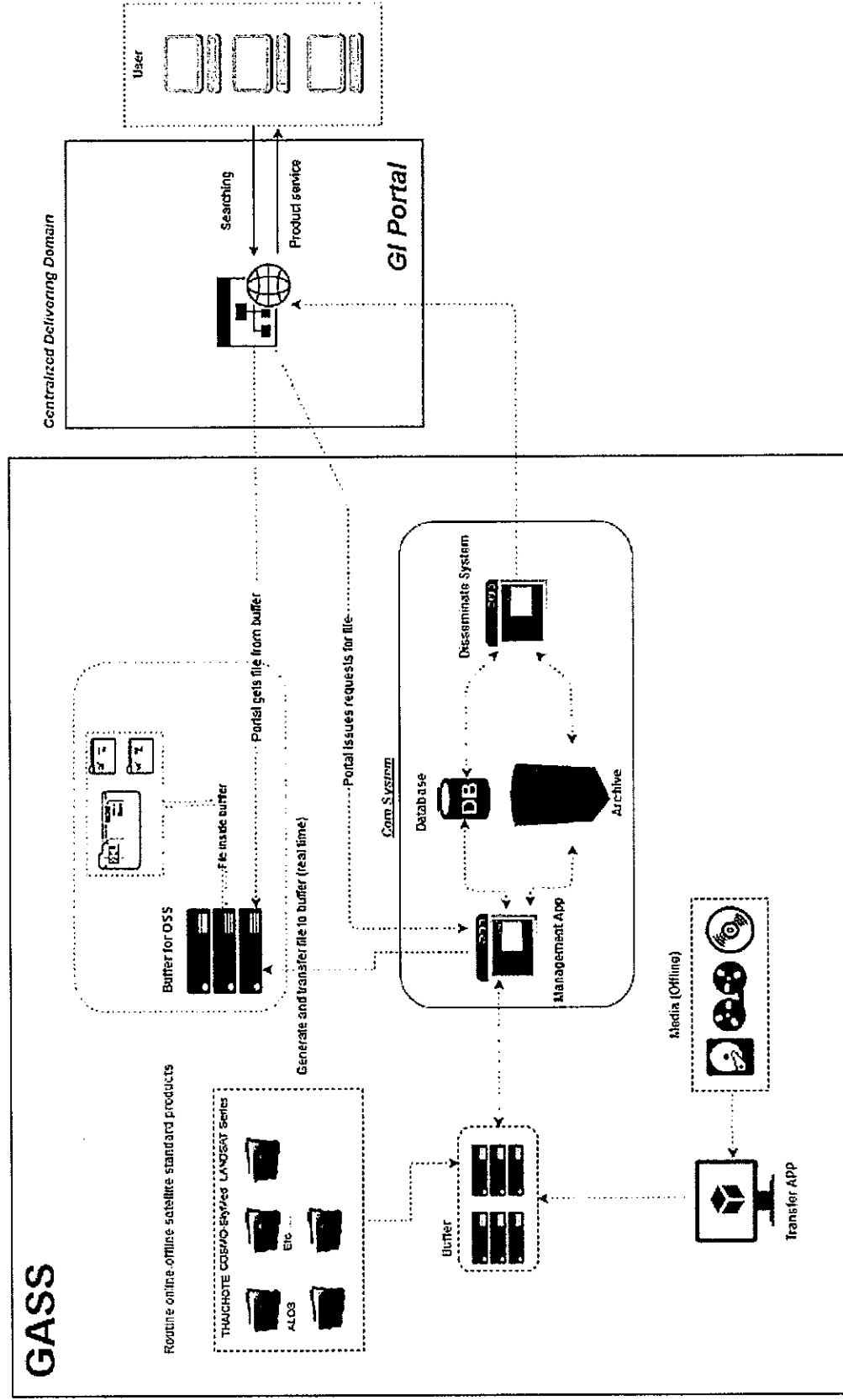
Maximum actual symbol rate	320 Mbps
Maximum Bit rate in BPSK mode	320 Mbps
Maximum Bit rate in QPSK mode	640 Mbps
Maximum Bit rate in 8PSK mode	960 Mbps
Maximum Bit rate in 16QAM / 16APSK mode	960 Mbps
Maximum Bit rate in 32 APSK mode	1,200 Mbps
Maximum Bit rate in 64 APSK mode	1,400 Mbps



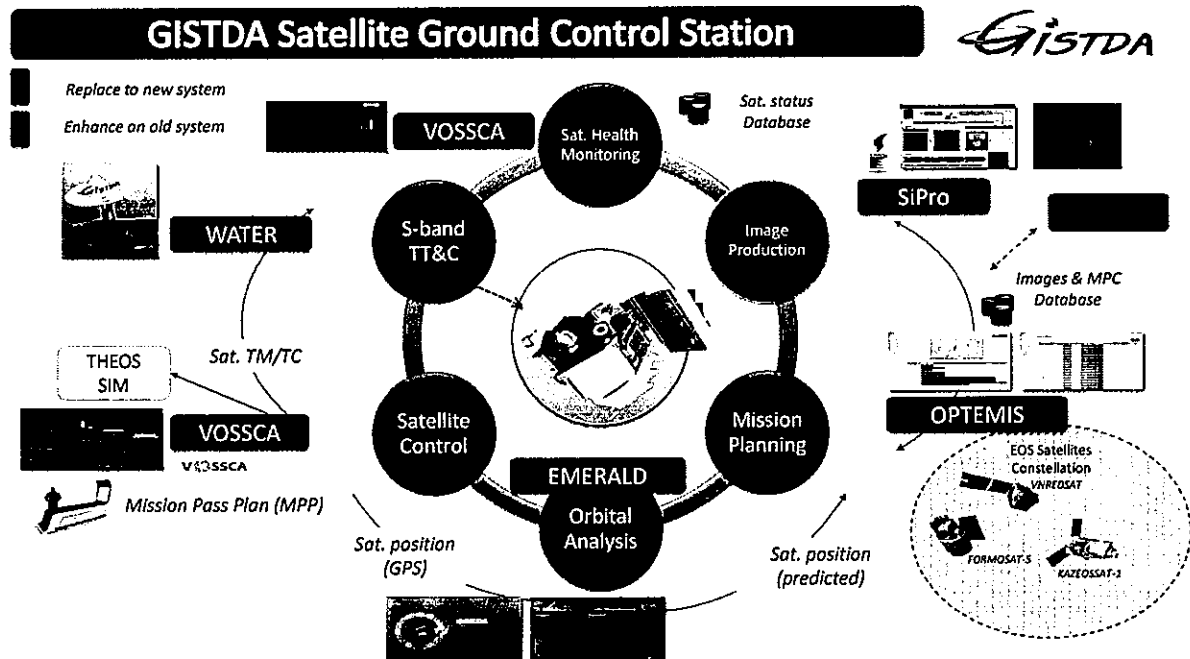
Operating Mode 2 and 3 (dual demodulator @ 720 MHz IF input)

Maximum actual symbol rate per channel	240 Mbps
Maximum Bit rate in BPSK mode per channel	240 Mbps
Maximum Bit rate in QPSK mode per channel	480 Mbps
Maximum Bit rate in 8PSK mode per channel	720 Mbps
Maximum Bit rate in 16QAM mode per channel	720 Mbps

2.4 Archiving System



2.5 GISTDA Ground system development



2.5.1 VOSSCA

VOSSCA is to be an interface between the control ground station and the satellite, which includes telecommand (TC)/mission plan transmission and telemetry (TM) reception. VOSSCA is applicable to be used as interface software for sub-systems testing during satellite AIV (Assembly-Integration and Validation) phase. It is also capable of handling many types of satellite TT&C protocols, for instance, CCSDS, CAIT, EDEN, PIPE or RPRO. The main advantage of VOSSCA is its capability to handle and perform an immediate TT&C switching between multiple satellites from a single software platform.

2.5.2 WATER

WATER (Wise Antenna for Transmission Execution and Receiving System) which aims to develop GISTDA's S-band antenna was initiated. WATER S-band antenna is a 6-meter antenna with hexapod type platform. The reflector is made as a sandwich structure with carbon-fiber skins over honeycomb core.

2.5.3 EMERALD

The EMERALD is the flight dynamic software for EO satellite. The system consists of three main modules which are the routine module (orbit determination tool, orbit propagator, event prediction and the station-keeping manoeuvre module). In addition, since

space debris has become a critical problem in the present-day space programs, the collision avoidance monitoring tool is also integrated into the system.

2.5.4 OPTEMIS

OPTEMIS is the mission planning software which is also designed by taking into account the scheduled area cloud coverage based on 24 hours in advance global cloud coverage prediction data. For the planning and scheduling module, the software is designed to be able to manage the optimized plan for multiple EOS satellites as long as the necessary satellite parameters (e.g. payload capability, satellite agility performances) are provided.

2.5.5 SIPROS

SIPROs (Self-developed Image Processing System for Thaichote Satellite) project has been initiated, studied, and developed with the purpose of assuring the continuity of the supply of Thaichote imagery as well as improving functions and features of the image processing systems. SIPROs will enable GISTDA to efficiently and effectively deliver standard satellite imageries to end-users and communities by promptly providing the most appropriate products both in term of quality and speed through features

The goal of SIPROs is to generate and deliver Thaichote satellite standard imageries which are radiometric corrected (Level 1A) and geometric corrected (Level 2A). This development will also open up the route to further system development thanks to its open platform python based software. It is also highly flexible and can be run on many different operating system. The final goal of the project is to employ single standard satellite imagery system that can support and manage every satellite imagery mission of GISTDA in the future.

2.6 Existing stand-alone applications

MISSION (1)			MAP (2)	Mapping/Monitoring	Modeling/Measuring (3)	Method (4)	API Managing (5)
Disaster	Fire impact	• Hotspot	Web Service, Shapefile, JPG, Excel, Kml	4 times / day	MODIS	MOD14	
		• Burn Scar	JPG, Map Service	Every 16 days	Landsat-8	Difference Normalize Burn Ratio	
		• Frequent imaging of Burnt area	JPG, Map Service	Annual		Accumulate	
		• Smoke way forest fire	JPG	Daily	AQUA	Object Oriented Classification	
		• Fire Risk	JPG, Map Service	Weekly	GIS and Remote data	PSA	
	Drought impact	• NDVI	JPG	Daily, weekly	MODIS	(NIR-RED)/(NIR+RED)	
		• NDWI	JPG	Daily, weekly	MODIS	(NIR-SWIR)/(NIR+SWIR)	
		• Flooding Area Coverage	Web Service, Shapefile, JPG, Excel, Kml	Event-based	Cosmo-Skymet, Radarsat, Thaichote, Landsat, MODIS	Threshold	
	Disaster prevention	• Number of Household in flood area	JPG, Table, Report	Event-based	Commercial software	GIS Analysis (Overlay)	
		• Frequent imaging of flooded area	GIS, JPG	Annual	Commercial software	Accumulate	
Rice monitoring (http://rice.gistda.or.th) and GISAgro (http://gisagro.gistda.or.th)	Landslide impact	• Landslide coverage (Study area)	GIS, JPG, Table, Report	Research	Hi-Resolution	Visualize Classification	
		• Rice Plantation	Report every two weeks (monitoring)	Yield estimation	MODIS		
	Vegetation	• General Vegetation status detection	Cultivated area		Thaichote / Hi-Resolution		
Forestry		• Forest Area	x		Thaichote / Landsat		

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MISSION (1)		MAP (2)	Mapping/Monitoring	Modeling/Measuring (3)	Method (4)	API Managing (5)
			x			
		- Forest Type - Forest encroachment - Green area	x	Hi-Resolution		
		- General Vegetation status detection - Chlorophyll level		Hi-Resolution		
Agriculture & Forest	Vegetation Soil		Rice plant date on web http://rice.gistda.or.th			
			NDVI calculation			

MISSION (1)		MAP (2)	Mapping/Monitoring	Modeling/Measuring (3)	Method/Methodo (4)	API Managing (5)	Remark (6)
Marine and Coastal Environment	Coastal Pollution (Oil spill/ water quality)	- Chlorophyll conc. - Sea surface Temp. map - Current speed and direction map - Oil tracking map - Land use map	- Oil monitoring from Radarsat/Cosmo skymed/ Thaichote/Landsat - Water quality monitoring from Modis	- Coastal radar software (Seadrift) - Mike oil spill modelling - Temas oil spill (e-Geos)	- Coastal radar network in GOT and Andaman sea - Terra/MODIS - Radarsat - Cosmo Skymed - Thaichote - Landsat - Hydrodynamic model (MIKE)	-Geo Spatial Platform for oil spill management - Water quality system	- Oil spill management (under MOU with DMCR and Chonburi province/ ad hoc.) - Water quality management (under MOU with DMCR / ad hoc.)
	Coastal erosion	- Erosion & Accretion map - Shoreline map - Coastal Vulnerability Index map (CVI map)	- Shoreline change monitoring - Current – wave – wind monitoring - Land use monitoring	- Digital Shoreline Analysis System (DSAS) - MIKE-Lithpack-Lithline - Building Information Model (BIM) – 3D coastal change - Erosion processing model	- Coastal radar network in GOT and Andaman sea - Terra/MODIS - Radarsat - Cosmo Skymed - Thaichote - Landsat - High resolution satellites - Hydrodynamic model (MIKE) -Geo spatial model	-Thailand coastal spatial database system (developing)	- Coastal erosion management (under MOU/MOC with DMCR)

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					(on ArcGIS)							
Marine resources	- Land price - Population - Household - Chlorophyll conc. - Sea surface Temp. - Current speed and direction - Wave height and period - Wind speed and direction	- Chlorophyll conc. Map - Sea surface Temp. map - Current speed and direction map - Marine habitat mapping (Mangrove/ coral map)	- Chlorophyll conc. Monitoring - Sea surface Temp. monitoring	- Coral mapping model (on ArcGIS)	- Coastal radar network in GOT and Andaman sea - Terra/MODIS - Radarsat - Cosmo Skymed - Thaichote - Landsat - Hydrodynamic model (MIKE) - Geo spatial model	-						
Maritime services	- Current speed and direction - Wave height and period - Wind speed and direction - AIS tracking - Vessel tracking	- Vessel location map - Current speed and direction map	- Vessel location monitoring (from AIS) - Vessel location monitoring (from Coastal radar - developing)	- Vessel tracking model (developing)	- Coastal radar network in GOT and Andaman sea - Terra/MODIS - Radarsat - Cosmo Skymed - Thaichote - Landsat - High resolution satellites - Geo spatial model	- Geo Spatial Platform for vessel tracking (developing)						
Climate change (Coral bleaching)	- Sea surface Temp. - Current speed and direction - Wave height and period - Wind speed and direction	- Coral bleaching mapping	- Sea surface Temp monitoring	- Coral bleaching mapping model (on ArcGIS)	- Coastal radar network in GOT and Andaman sea - High resolution satellites - Geo spatial model	-						
Coastal environmental monitoring	- Chlorophyll conc. - Sea surface	- Chlorophyll conc. Map - Sea surface	- Chlorophyll conc. - Sea surface	- Coastal radar measuring - Satellite	- Coastal radar network in GOT and Andaman sea (http://coastalradar.gistda.or .)	-				Coastal environmental condition (Chlo-		

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		Temp. - Current speed and direction - Wave height and period - Wind speed and direction	Temp. map - Current speed and direction map	Temp. - Current speed and direction - Wave height and period - Wind speed and direction	processing model	th)		SST- Cur-Wave-Wind)
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