

For discussion
on 25 February 2019

Legislative Council Panel on Economic Development

**Replacement of Storm-detecting Weather Radar at Tai Mo Shan and
Procurement of a High Performance Computer to
Enhance High-impact Weather Forecast**

PURPOSE

This paper seeks Members' support for the proposal of the Hong Kong Observatory (HKO) to (a) replace an ageing storm-detecting weather radar at Tai Mo Shan (TMS) and (b) procure a high performance computer system, so as to enable HKO to sustain quality weather services to the Hong Kong community and enhance its capability for forecasting and monitoring high-impact weather affecting Hong Kong.

JUSTIFICATIONS

2. HKO is the official meteorological authority in Hong Kong. It is committed to providing quality weather services to the general public and specialised users in the aviation and marine community. Timely and reliable weather forecasts and warnings are crucial in order to ensure our community can get better prepared for the evolving weather conditions on a daily basis and, more importantly, help reduce loss of life and damage to property and minimise disruption to economic and social activities during hazardous weather. To enable HKO to deliver such a critical mission, HKO has to count on the support of up-to-date meteorological equipment and systems. Storm-detecting weather radars and high performance computers are two cases in point.

Storm-detecting Weather Radar at TMS

3. At present, HKO operates two storm-detecting weather radars. Housed in stations located at remote hilltops at TMS (**Annex A**) and Tate's Cairn, these

storm-detecting weather radars are primarily used for monitoring heavy rain and strong wind associated with severe weather (such as tropical cyclones)¹. Information gathered by the radars is crucial to HKO for tracking the movement and strength of severe weather systems, thus enabling HKO to provide timely forecasts and warnings, such as those related to tropical cyclone, thunderstorm, rainstorm, flood and landslip.

4. The two weather radars work in tandem to ensure the quality and uninterrupted availability of the weather data. At times when any radar in the pair is not serviceable due to maintenance or repair, HKO will rely on the other radar to maintain weather services to the general public.

5. Between the two existing radars, the one at TMS was commissioned in 1999 and has been in operation for around 20 years, which is significantly longer than its normal serviceable life time. A number of critical spare parts for the radar at TMS are now out of production. Given HKO's declining stock of these critical spare parts, the existing TMS radar can hardly maintain proper functioning beyond 2022. Timely replacement of the radar at TMS is essential for sustaining the forecast and warning services relating to severe weather. Taking into account the lead time required for procurement, installation and testing, we need to secure funding approval from the Finance Committee (FC) of the Legislative Council (LegCo) for the replacement radar in the second quarter of 2019.

6. Subject to funding approval from FC, HKO will procure the replacement radar by way of open tender. The specifications of the proposed replacement radar for TMS would be largely similar to the weather radar at Tate's Cairn (commissioned in 2015²), including the "dual-polarisation" feature for providing additional information to allow more accurate estimation of rain intensity. Since the existing radar at TMS was procured two decades ago, the proposed replacement radar would be able to capture the latest technology in delivering the relevant functions.

¹ The two radars can detect and estimate the intensity and location of rain up to 500 km from Hong Kong, as well as wind information up to 250 km from Hong Kong respectively. The Tate's Cairn weather radar, which was procured more recently, possesses more advanced capabilities and helps monitor other severe weather conditions such as hails.

² The preceding radar at Tate's Cairn had been in use for about 20 years since 1994, before it was replaced by the existing radar in 2015.

7. The estimated implementation schedule of the project is as follows –

Implementation stage	Target completion date
Tender invitation	June 2019
Award of contract	December 2019
Delivery of new radar to site	October 2021
Renovation of radar station	March 2022
Installation of new radar	March 2022
Testing and commissioning of new radar	August 2022

8. During installation and testing of the replacement radar, HKO will rely on the Tate's Cairn weather radar and other backup arrangements for storm detection to minimise impact on weather services.

9. Effective radiation safety measures in accordance with international standards will also be included in the tender technical requirement to ensure that the new radar fully meets the radiation safety requirements.

High Performance Computer (“HPC”) System

10. Similar to other weather centres, HKO adopts Numerical Weather Prediction (NWP) as one of the basic tools for weather forecasting. Under the NWP approach, future weather is simulated on HPC systems by mathematical models. The outputs from such simulations (for parameters including pressure, wind, temperature, humidity and rainfall) provide useful basis for experienced weather forecasters to formulate weather forecasts for the public and specialised users. Such outputs are particularly crucial for HKO to provide an early forecast of high impact weather such as tropical cyclone and heavy rain. The NWP simulation process involves a huge volume of meteorological data and complicated mathematical models, and therefore requires significant computing resources.

11. Between the two existing HPC systems of HKO, the one supporting public weather forecast was commissioned in 2010³. Its normal serviceable life

³ The other existing HPC system was commissioned in 2013, and is primarily used for aviation weather service purposes and covers mainly the Hong Kong International Airport (HKIA) area.

time is five years but has been extended to date through system upgrade in 2014. However, upon a more recent review, HKO sees the need to enhance the whole system, as the existing HPC system only has a total computing power of 0.0264 petaFLOPS⁴ and is unable to meet HKO's latest operational needs. For example, the existing system can only support NWP models for weather forecasts up to three days ahead at a horizontal resolution of ten kilometres, and up to 15 hours ahead at a higher horizontal resolution of two kilometres. For weather forecasts beyond the aforementioned periods, HKO has to rely entirely on NWP data from overseas meteorological authorities and centres. Such overseas NWP data could not always provide the necessary details regarding the weather conditions in and around Hong Kong, and the frequency of updating (only two to four times a day) falls short of HKO's requirement of at least eight times a day.

12. In light of the above limitations with the existing system, and having balanced the costs and benefits concerned, HKO considers it optimal for the proposed HPC to have a higher computing power in the order of 1.3 petaFLOPS for generating more detailed local weather forecast for Hong Kong up to at least five days ahead and at a finer horizontal resolution up to 24 hours ahead⁵.

13. When compared with the existing HPC for public weather services, the proposed HPC would be able to run NWP model at higher resolution to better capture spatial difference and the detailed topography of Hong Kong, which are important factors affecting forecasts on regional weather conditions (such as temperature and wind strength) and short-lived weather phenomena (such as rainstorms). The proposed HPC will also enable the running of the NWP model for multiple times with slightly different settings, thereby providing stronger support for probabilistic forecasts of high-impact weather (such as tropical cyclone and rainstorm). Moreover, the proposed HPC, by working with the other existing HPC for HKIA (see footnote 3 above), will help improve weather services for specialised users, such as the aviation community, by generating probabilistic forecasts on the trajectory of aircraft under the effect of hazardous weather.

⁴ PetaFLOPS is a common metric used for measuring the performance of computing systems. One petaFLOPS means performing 1×10^{15} floating point operations per second.

⁵ For local forecasts over a longer term, HKO will continue to make reference to NWP data from overseas meteorological authorities.

14. The proposed HPC will also contribute to the provision of urban-scale weather forecast when combined with the data from the Multi-functional Smart Lamppost Pilot Scheme, one of the initiatives in the Smart City Blueprint under the Innovation and Technology Bureau. Furthermore, the NWP model run by the proposed HPC is expected to support a number of international meteorological projects undertaken by HKO, notably those relating to nowcasting of high-impact weather events in Asia for reference by meteorological organisations in the region. Through taking part in these international projects, HKO can benefit from wider exchange of weather data with other meteorological authorities which can in turn support its core duties of providing weather services for Hong Kong.

15. Subject to FC's funding approval, HKO will procure the new HPC by way of open tender. Early preparation for drawing up the specifications, taking into account the required features as mentioned above, is underway. Taking into account the lead time required for procurement, installation and testing, the new HPC is expected to come into operation in 2022⁶.

16. The estimated implementation schedule of the project is as follows –

Implementation stage	Target completion date
Tender invitation	June 2020
Award of contract	September 2021
Delivery and installation of HPC	July 2022
Software development	
Testing and commissioning of HPC	

⁶ Upon commissioning of the replacement HPC, the existing HPC will be deployed for other supportive functions for processing of NWP outputs, such as generation of weather maps and graphics, and for research work.

FINANCIAL IMPLICATIONS

17. The estimated costs of replacing the Storm-detecting Weather Radar at TMS and procuring the proposed new HPC are as follows –

	Storm-detecting Weather Radar at TMS (\$ million)	Proposed new HPC (\$ million)
Non-recurrent costs	48	90
Recurrent costs per annum	2.4 (full-year effect from 2023-24)	11.5 (full year effect from 2023-24)

Please refer to **Annex B** (TMS radar) and **Annex C** (HPC) for details of the breakdown of expenditures.

WAY FORWARD

18. Subject to Members' support for the above proposal, we plan to seek funding approval from the LegCo FC in the second quarter of 2019.

Commerce and Economic Development Bureau
Hong Kong Observatory
February 2019

Existing Storm-detecting Weather Radar Station at Tai Mo Shan



**Estimated Non-recurrent and Recurrent Expenditure for
the Proposed Replacement of the Storm-detecting Weather Radar at TMS**

Non-recurrent Expenditure	\$ million
(a) Hardware (including initial spare parts, consumables and test equipment)	32.2
(b) Software	4.5
(c) Delivery, installation, testing, commissioning, documentation and training services	6.9
(d) Contingency (10 % of (a)+(b)+(c))	4.4
Total*	48.0

* We estimate that an additional non-recurrent expenditure of about \$15 million would be required for station improvement works. The required funding will be separately sought from the relevant block vote.

Cashflow projection

Financial Year	2020–21	2021–22	2022–23	2023–24	Total
Non-recurrent expenditure (\$ million)	1.1	3.3	39.1	4.5	48.0
Financial Year	2020–21	2021–22	2022–23	2023–24 and onwards	
Recurrent expenditure[#] (\$ million)	—	0.5	0.5	2.4 per annum	

The recurrent expenditure is for meeting costs for spare parts and consumables, light and power and rental of communication line, etc.

**Estimated Non-recurrent and Recurrent Expenditure for
the Proposed HPC System**

Non-recurrent Expenditure	\$ million
(a) Contract staff for software development	3.8
(b) Hardware, software and implementation services of the HPC system	78.0
(c) Contingency (10 % of (a)+(b))	8.2
Total	90.0

Cashflow projection

Financial Year	2020–21	2021–22	2022–23	2023-24	Total
Non-recurrent expenditure (\$ million)	1.1	2.1	78.2	8.6	90.0
Financial Year	2020–21	2021–22	2022-23	2023–24 and onwards	
Recurrent expenditure[^] (\$ million)	—	—	2.5	11.5 per annum	

[^] The recurrent expenditure is for meeting maintenance costs, light and power, etc.