International Civil Aviation Organization

Workshop and One Day PSIDS meeting for preparation of new-CRV requirements and specifications for future SWIM/other aviation services
Guam, USA, 17-20 September 2024

Agenda Item 2: Lesson Learned from Joint Events of SWIM-over-CRV Demonstration and Surveillance Data Sharing in SWIM Technical Trial
Agenda Item 3: New CRV Technical Specifications including SWIM requirements

Study on bandwidth used for ADS-B data being transmitted on SWIM/CRV

(Presented by Hong Kong, China)

SUMMARY

Hong Kong, China has been actively supporting the CRV implementation and various ICAO initiatives in the region utilizing CRV as communication infrastructure, such as SWIM, ATFM and surveillance data sharing. This paper presents a study on the bandwidth used for the ADS-B data transmitted over the SWIM/CRV environment and provides insights and analysis.

1. INTRODUCTION

1.1 During the CRV OG meetings, there was a recognized need to review and analyze the bandwidth usage of CRV in each State/Administration. Such analysis is crucial to proactive planning of upgrades and accommodating future applications, ensuring necessary actions will be taken timely.

1.2 The existing CRV was designed to support Voice and AMHS services. After operational use of CRV in August 2018, it was recommended and agreed by both CRV OG and SWIM TF for CRV to be the underlying infrastructure to carry SWIM data. The current CRV contract, spanning a term of 10 years, will conclude in 2028. The renewal tendering process is currently underway.

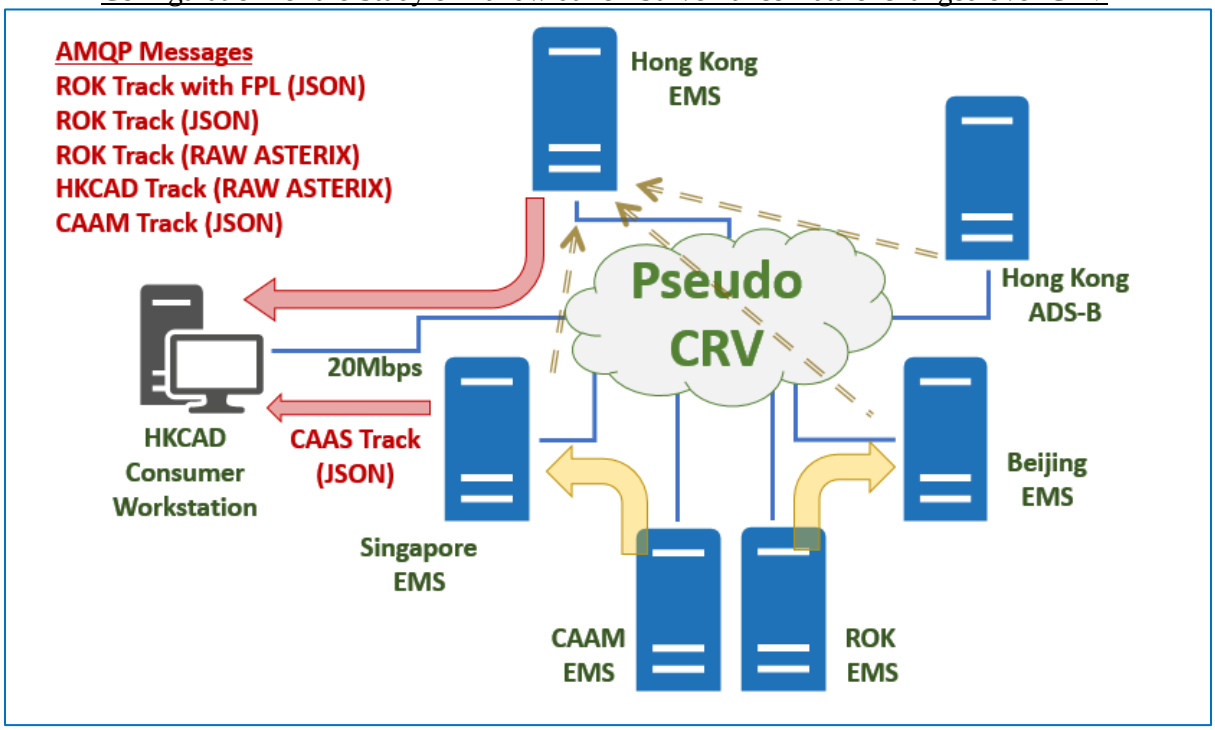
1.3 Since bandwidth in CRV is considered a crucial resource, especially for States/Administrations with higher bandwidth demand due to higher number of applications and States which are geographically remote understandably with higher bandwidth cost. This study is to offer insights into the bandwidth requirements of surveillance data on SWIM, so that CRV experts could consider incorporating them into the tendering process for improved support of new applications.

1.4 The SURSG chaired by Hong Kong China has undertaken the responsibility to conduct a study on the sharing of surveillance data over SWIM and a demonstration of surveillance data sharing taking place 28-29 May 2024 (the Demo). One crucial aspect of this study revolves around the bandwidth requirements. This paper seizes the opportunity accorded by demonstration to collect and analyze the associated bandwidth usage of the sharing of surveillance data.

2. DISCUSSION

Setup for the Study

Configuration for the Study of Bandwidth on Surveillance Data exchanged over CRV



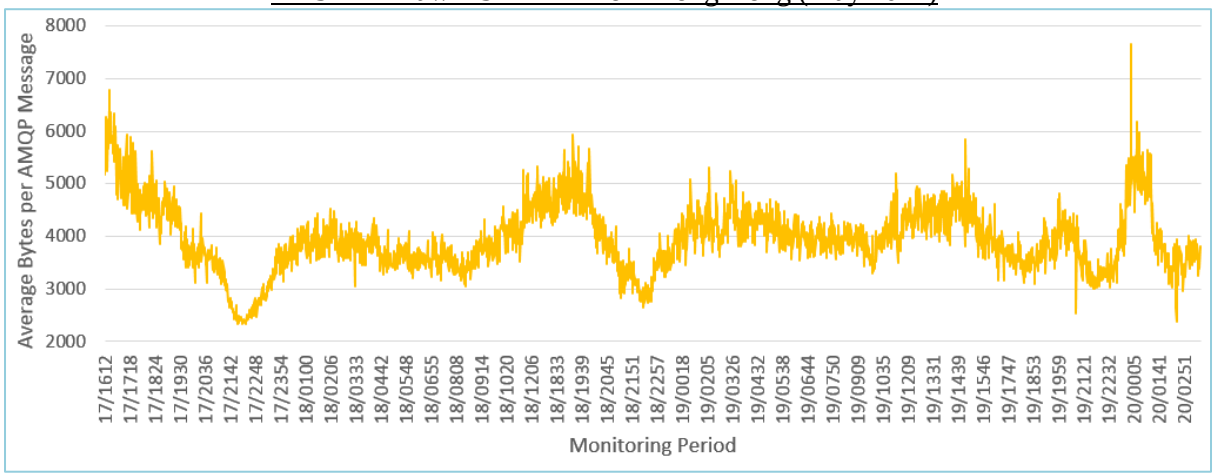
2.1 For the Demo, a 20Mbps connection to Pseudo CRV has been established in Hong Kong. A consumer workstation was configured to receive AMQP messages containing **surveillance data in JSON and raw ASTERIX**, and **surveillance data associated with FPL in JSON** from Hong Kong EMS. The HKCAD track is initially converted by HKEMS from the Hong Kong ADS-B system. The ROK (Republic of Korea) and CAAM (Civil Aviation Authority of Malaysia) tracks are relayed through Beijing EMS and Singapore EMS, respectively.

2.2 This analysis was based on the ADS-B surveillance data encapsulated in an AMQP message received by HKCAD Consumer Workstation between 17 and 20 May 2024. In parallel, the workstation accompanying by the widely-used software Wireshark also captured all incoming traffic for further verification and comparison. Further to this, CAAS's messages were directly captured between 15 Aug and 6 Sep 2024 for study too. Following post-processing of the data files to generate statistical information for analysis, findings are summarized in ensuing paragraphs.

Illustration of AMQP Messages Received from Different EMS

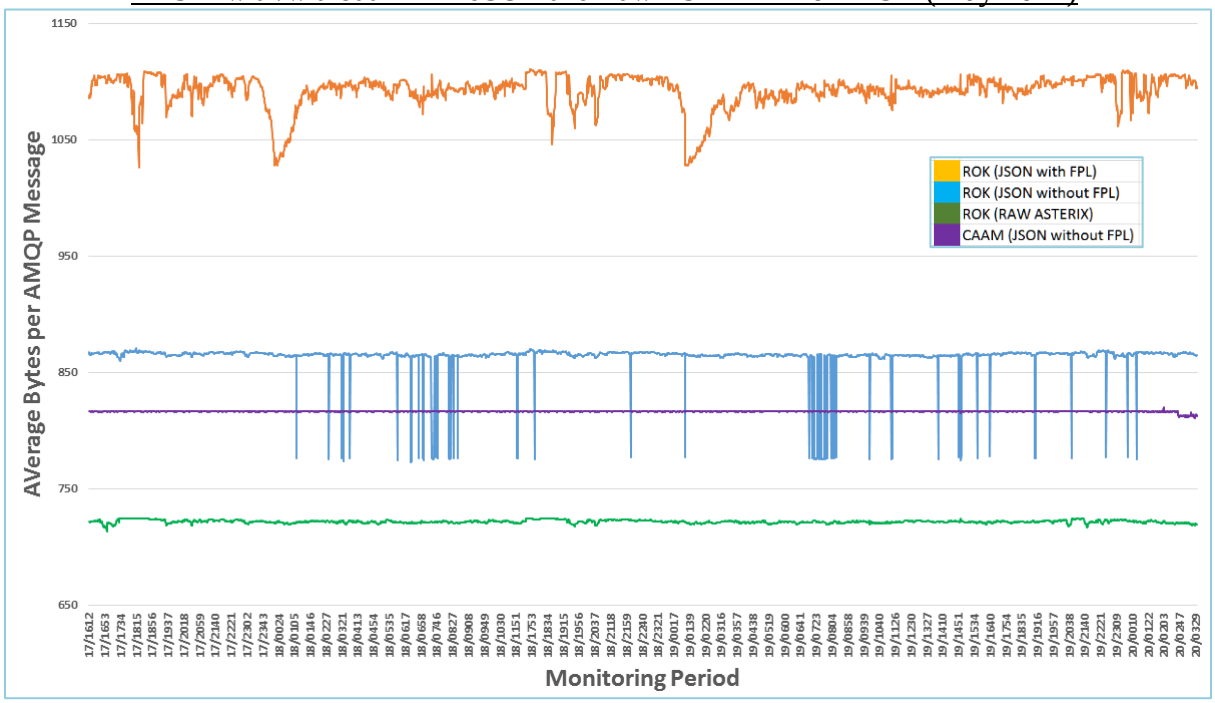
2.3 The analysis was based on the size of an AMQP message received from different EMSes. Average size in bytes per message over one-minute interval during the said monitoring period (17-20 May 2024) is plotted in the charts below.

ADS-B in Raw ASTERIX from Hong Kong (May 2024)

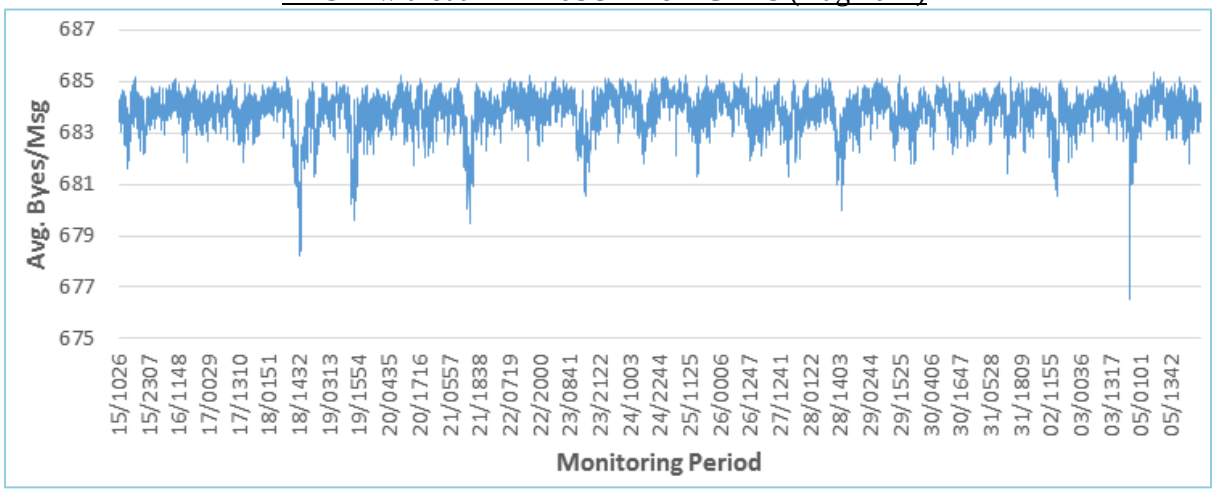


2.4 Hong Kong EMS takes the approach to pack multiple ADS-B CAT21 target data in a single AMQP message and the number of targets to be packed depends on how much target information has been received in predefined timeframe. It provides a reason why the average byte per message published by Hong Kong EMS is fluctuated. Such approach has no flexibility to associate with Flight Plan information to be included in the message header such as Aircraft ID since there are multiple aircraft targets. On the other hand however, it can reduce the transmission overhead by comparing with 1 target 1 message approach.

ADS-B without FPL in JSON from CAAM, and
ADS-B with/without FPL in JSON and Raw ASTERIX from ROK (May 2024)

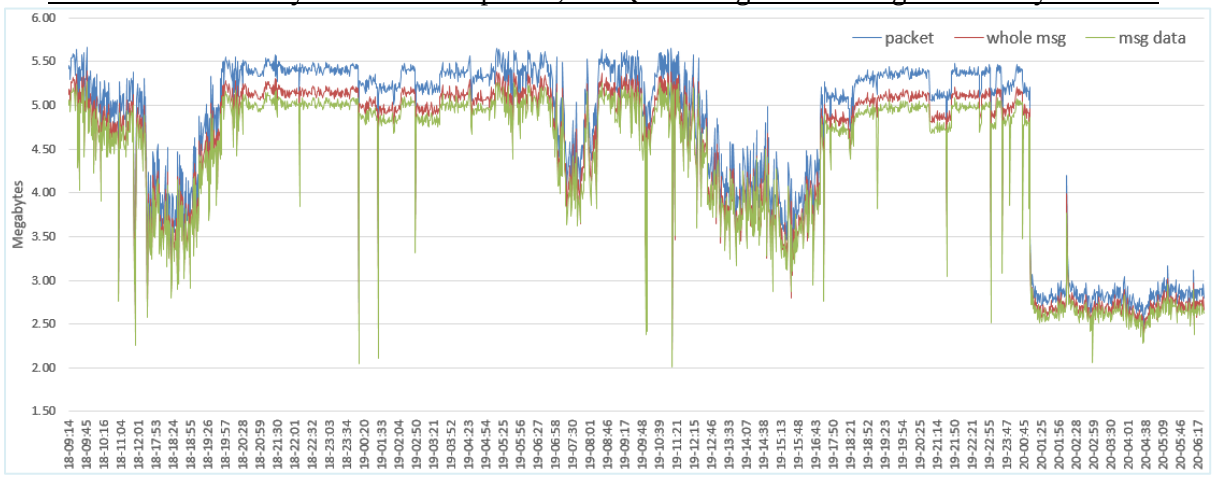


ADS-B without FPL in JSON from CAAS (Aug 2024)



2.5 Unsurprisingly, an average AMQP message carrying both ADS-B target data and FPL information in a JSON format contains more bytes than the AMQP message carrying ADS-B in raw ASTERIX. It is also reasonable to note that the AMQP messages carrying only ADS-B data without FPL in JSON sent by ROK, CAAM and CAAS are of similar size.

Cumulative size in bytes of network packet, AMQP message and message data every 1 minute



2.6 Furthermore, when comparing the size of network packets captured in Wireshark with the size of the AMQP message data (header + body), it is observed that the network packets are approximately 8% larger than the message data. This observation offers insights into the size of AMQP overhead when transmitting a message.

2.7 The statistical data presented above illustrates the bandwidth utilization for various formats of surveillance ADS-B data. With reference to ROK's AMQP messages carrying both ADS-B data and Flight Plan information, most of messages contain 32 data fields, which is the highest number among the messages received. It is observed that such messages in JSON format occupies approximately 1.1K bytes, which is the largest size among all messages exchanged in this study. If the 8% transmission overhead is included, the size increases to around **1.2K bytes**.

32 data fields in AMQP message received from ROK

#	Message Header
1	APAC_ACID
2	APAC_ARR_AIRPORT
3	APAC_DEP_AIRPORT
4	APAC_CATEGORY
5	APAC_CATEGORY_VERSION
6	APAC_EOBT
7	APAC_GUFI
8	APAC_MESSAGE_TYPE
9	APAC_RECIPIENT_LIST
10	APAC_SOURCE
11	APAC_SYSTEM
12	APAC_TIMESTAMP
13	CamelJmsDeliveryMode
14	breadcrumbId

#	Message Body
15	ACID
16	FL
17	GS
18	SIC
19	SAC
20	SSRCODE
21	DT
22	HEADING
23	ARCADDR
24	QITYPE
25	QI
26	LAT
27	LONG
28	GUFI
29	ADEP
30	ADES
31	ARCTYPE
32	WKTRC

Further Analysis

2.8 In Hong Kong China's operational environment, during peak hours, the Hong Kong ADS-B system detects approximately 300 targets within Hong Kong FIR and partial Mainland China FIR. Assuming that ADS-B data associated with Flight Plan information for all these 300 targets are sent in 1 second in SWIM environment with each target of size of 1.2K bytes (refer to ROK track), a total of 360K bytes per second is necessary (i.e. 2.88Mbps). As Hong Kong is one of the busiest FIRs in the region, this figure should offer additional insights that the bandwidth demand may be capped at this level in the worst scenario.

2.9 Having said above, the bandwidth requirement still highly depends on different use cases. Several aspects, particularly the frequency of data sent, should be considered by different States/Administrations.

3. ACTION BY THE MEETING

3.1 The meeting is invited to:

a) note the study conducted by Hong Kong China and take it into consideration for new CRV technical specifications;

b) encourage States/Administration using SWIM/CRV to share their experience in conducting similar monitoring and analysis; and

c) discuss any relevant matter as appropriate.

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