INTERNATIONAL CIVIL AVIATION ORGANIZATION

ASIA AND PACIFIC (APAC) OFFICE

Surveillance Study Group (SURSG)

STUDY REPORT

Surveillance Data Sharing - Feasibility Study Stage

- Implementation Model
- Infrastructure Model
- Business Model
- Participation Model
- Implementation Roadmap

China
Hong Kong, China
Republic of Korea
Singapore
Thailand
Viet Nam

Table of Contents

ACRONYMS AND ABBREVIATIONS

A-CDM	Airport Collaborative Decision Making
ADS-B	Automatic Dependent Surveillance - Broadcast
AIXM	Aeronautical Information Exchange Model
ANSP	Air Navigation Service Provider
APANPIRG	Asia/Pacific Air Navigation Planning and Implementation Regional Group
ASEAN	Association of Southeast Asian Nations
ASBU	Aviation System Block Upgrades
ASTERIX	All Purpose Structured Euro control Surveillance Information Exchange
ATFM	Air Traffic Flow Management
CONOPS	Concept of Operations
CRV	Common aeRonautical Virtual Private Network
CRV OG	CRV Operations Group
CTOT	Calculated Take Off Time
EMS	Enterprise Messaging Service
FIXM	Flight Information Exchange Model
GANP	Global Air Navigation Plan
IWXXM	ICAO Meteorological Information Exchange Model
MET	Meteorological
MLAT	Multilateration
MQ	Message Queue
NUC/NIC	Navigation Uncertainty Category/Navigation Integrity Category
POC	Proof of Concept
SAC	System Area Code

SCDP	Surveillance Central Data Processor
SDDS-NG	Surveillance Data Distribution Solution Networking Group
SIC	System Identification Code
SLA	Service Level Agreement
SURICG	Surveillance Implementation Coordination Group
SURSG	Surveillance Study Group
SWIM	System Wide Information Management
SWIM TF	SWIM Task Force

Chapter 1: IMPLEMENTATION MODEL (TASK 2-2)

1.1 Introduction

1.1.1 SWIM could be the key driver to the implementation of surveillance data sharing as the SWIM platform can be adapted to realize data sharing across different States, in addition to the exchange of expected SWIM data traffic such as FIXM, AIXM, and IWXXM messages. Working papers in relation to collaboration in sharing of surveillance data in SWIM presented to SWIM TF/4 (WP/13) and CNS SG/24 (WP/22) are highly relevant to this chapter.

This chapter focuses on the implementation approach and practical implementation models with particular air traffic control operation identified and infrastructure services required to realize surveillance data sharing. This chapter also considers the system design and collaboration model expected for implementation of surveillance data sharing.

1.2 Implementation Philosophy

1.2.1 "Bottom up" and "Starting small and simple" – ADS-B data to be shared

a) To align with the philosophy and roadmap for implementation of SWIM in APAC, the same incremental approach (i.e. starting small and simple) will be leveraged for surveillance data sharing in SWIM. With focus on one operation selected to benefit from surveillance data sharing, the infrastructure and associated information service would be identified and implemented to efficiently support the operation. Where the first implementation of surveillance data sharing of ADS-B data proves feasible and beneficial, sharing of other types of surveillance data may take reference from and be leveraged on the mechanism and infrastructure established for the previous case.

b) Given data ownership, concerns and considerations of potential contributors of other surveillance data types, a one-size-fits-all model capable of catering to multiple surveillance data types would be too complex and with too many considerations to render this Study Report easily readable and its proposed sharing model implementable since an all-encompassing model would imply elaborate and extensive ground works, infrastructure, papers, documentation and agreements to be sorted out first. Unless most other surveillance data types, ADS-B data is self-initiated and broadcast to all by aircraft and is easier to be shared with well-established data format standard. Therefore the scope of this study is devoted to the sharing of ADS-B data.

c) Currently, ADS-B CAT 21 Version 2.1 format has been the common standard in the aviation community since its publishing in 2011. While for the sake of compatibility it may be tempting to specify the upcoming or a list of legacy versions in this Study Report, such a comprehensive approach would be discouraging to potential data contributors and could complicate matters with extra version conversion efforts, which would add to data latency and lead to potential query of data integrity due to extra processing and conversion. It is best to aim for one standard version of ADS-B data in the implementation. Where a data contributor's data is of a different version, such data should not be rejected however, since in the publish-n-subscribe mechanism of SWIM and its service registry, a data recipient should be fully aware of the data version although it is desirable that a single standard prevails in the surveillance data sharing scheme without an intervening version conversion service to be provided by a the data contributor or a 3rd party.

1.2.2 Start with Particular Operational Application - ATFM

Air Traffic Flow Management (ATFM) is an application that could benefit from surveillance data sharing to facilitate air traffic planning, particularly as its demand on target update rate is much relaxed (as far apart as in minutes) than, say, ATC (normally within 8 seconds), which otherwise could have called for strong commitments from data contributors on data reliability and timeliness, which could dissuade a potential data contributor from participating. Even if it is not expected that at start of the surveillance data sharing initiative with contiguous coverage from departure to destination across FIRs, surveillance data showing nearly real-time take-off time would be of strong interest to the ANSPs of the concerned arrival/en-route flights.

1.3 Required Infrastructure and Information Service – SWIM over CRV

1.3.1 ToR of SURSG – a part of the ToR is the study on the "Sharing of Surveillance Data in SWIM", for which CRV has been endorsed as the carrier of SWIM data at CRV OG/5 and SWIM TF/3 meeting, it is therefore assumed that SWIM over CRV is the platform on which this Study is based considering that the CRV is a flexible, trusted, secure, well-governed (by CRV OG) and well-maintained network infrastructure, which is **already existent** with a user base of 16 subscribers (as at 23 December 2021) and growing.

1.3.2 Assumptions:

a) No assumption is made that CRV is the sole network capable of supporting the sharing of surveillance data but a practical assumption is made that the establishment of a separate, trusted and secure network for surveillance data sharing, even if built upon the Internet, would still require heavy commitments (costs and resources), involvement by active participants and guidance from ICAO APAC to ensure a reliable, well governed and well maintained network system and adequate bandwidth, which are already available under CRV.

b) While SWIM information services such as service discovery, governance, Certificate Authority (CA) services and applications are yet to be realized, a reasonable assumption is made that a somewhat rudimentary implementation of surveillance data sharing is possible at start without SWIM and the implementation could be assimilated into the SWIM environment as the SWIM services and applications become available over time.

c) An assumption is also made that the sharing of surveillance data (not just ADS-B data) in SWIM over CRV would secure the endorsement at a suitable time. It is envisaged that SWIM over the readily accessible CRV be the means to share the surveillance data such that States could benefit from SWIM initiatives without high initial investment cost for a new platform and development expense of traditional systems.

d) The readiness of the infrastructure and information service for implementation of surveillance data sharing is highly dependent on the implementation of SWIM. Insofar as this Study Report covers the various facets of sharing of ADS-B data in SWIM over CRV, no assumption is made that ADS-B data sharing could only commence when the supporting infrastructure and services are mostly available given the developing status of SWIM in APAC. It is also possible that sharing of ADS-B data could be migrated to SWIM as SWIM takes onto a substantial status of development.

1.4 Consideration of System Design – Hybrid SWIM Model

1.4.1 The SWIM infrastructure for surveillance data sharing could be implemented in either Distributed Model, Centralized Model and/or Hybrid Model (details in Chapter 2). By taking into account the efficiency and effectiveness of the implementation (again "starting small and simple" philosophy), Hybrid Model, representing the coexistence of ANSPs operating their own EMSes (Distributed Model) and ANSPs accessing centralized SWIM services provided by

government or commercial concerns (Centralized Model) is considered a suitable model. In gist, the Hybrid Model:

a) can cater to States with different levels of commitment to SWIM from operating their own EMSes (Distributed Model) to accessing SWIM services via centralized services provided by a 3rd party (Centralized Model); and

b) more importantly, allows for potential participation from commercial party(ies), which are expected to accelerate SWIM implementation and therefore sharing of surveillance data.

1.4.2 While States may subscribe to CRV if they choose to, the Hybrid Model could serve as the gateway for interested parties who are not subscribers of CRV to be able to share/receive surveillance data through connecting to a 3rd party(ies) that hosts the EMS and centralized services, subject of course to the endorsement from CRV OG. SWIM TF, CNS SG in future in accepting such a scheme.

1.5 Collaboration Model

1.5.1 Data Contributor – Eligibility

1.5.1.1 On the eligibility to share, member states/administrations are most welcome to share their data.

1.5.2 Data Contributor - Service Level of Shared Surveillance Data

1.5.2.1 Reliability and availability of the shared surveillance data are determinative factors on the success of implementation and degree of participation. It is essential that the shared data service reaches certain performance levels. In Appendix 6 "*Baseline ADS-B Service Performance Parameters*" of ICAO'S *ADS-B Implementation and Operations Guidance Document Edition 13.0 – September 2020*, there are some major performance requirements of ADS-B which are relevant to surveillance data sharing from potential data contributors: [See Chapter 3]

Service Parameters	~~Tier~~ Level 1[1]	~~Tier~~ Level 2[2]
System Availability	Total Service Availability > 99.9%	Total Service Availability > 90%
System Reliability	Total Service MTBF > 50,000 hours	Total Service MTBF> 200 hours
Aircraft Updates	0.5 second < Interval < 10~~5~~ seconds	0.5 second < Interval < 60 seconds
Data Latency	95%: < 2 seconds	95%: < 60 seconds

1.5.2.2 It is justifiable to follow the above requirements for the sharing of surveillance data. Yet, practically, the requirements, particularly for ~~Tier~~ Level 1 service level, can present themselves as obstacles for a potential data contributor unless:

a) the potential contributor is already providing such data via another channel with the required service performance level and the shared data represents simply data duplication into another channel for sharing;

b) the service level is non-binding; and/or

c) such service is provided "as is".

[1] ~~Tier~~ Level 1 standards are for a high performance traffic separation service.
[2] ~~Tier~~ Level 2 standards are for a traffic situational awareness service with procedural separation.

1.5.2.3 There exists a dilemma where a potential data contributor may be discouraged because of demands of required service level performance imposed on the contributor whereas a use-at-your-own-risk approach with no service guarantee would lessen the appeal/trust of the shared data for operational use not that this would necessarily discourage interested parties from participating as such data might still serve "for reference" and considered "nice-to-have". Such consideration might argue for the case of a trial implementation by pioneering members to showcase the benefits of the surveillance data scheming. [See Chapter 3]

1.5.2.4 Para. 1.5.2.3 also echoes the Implementation Philosophy in para. 1.2 to start small and simple and to start with an application, i.e. ATFM, where the less stringent service parameters of ~~Tier~~ Level 2 (compared to those of ~~Tier~~ Level 1) would still serve the purpose. At the same time, it also highlights an expected advantage of centralized services by a 3rd party to shoulder such service performance parameters (subject always to external factors beyond control). [See Chapter 3]

1.5.3 Data Consumer – Eligibility

1.5.3.1 On the eligibility to receive shared data, there are various options proposed in the CONOPS (SURICG/7-IP/17):

a) Option 1: The data to be shared among all participating users, be they data contributors or pure consumers

b) Option 2: A data contributor to decide which user(s) to receive the data and the volume of surveillance coverage

c) Option 3: By default, only data contributors can be consumers

In order to support the ATFM operation identified in para. 1.2.2 above, Option 1 is highly recommended as it resonates with the spirit of surveillance data sharing. Non-targeting data sharing would help speed up the collaborative sharing of surveillance data with a faster growth of the community, given the benefits derived from shared surveillance data and active States wishing to contribute and play an active part in this initiative, perhaps as a reference model or implementation experience for exchange of aviation data in an increasingly connected aviation community.

Options 2 and 3 may be implemented as the data sharing scheme further develops over time. Both options likely would involve complex and extensive multi-lateral discussions and agreements to reach detailed arrangements of data sharing. Options 2 and 3, clearly with some implied exclusivity, does not align well with ICAO's ASBU initiatives – global connectivity and is not recommended to avoid the scheme ending up a few participants with localized interests sharing data among themselves. For practical consideration, it is therefore desirable consider lessening or shifting the "burden" on a data contributor to a 3rd party providing centralized services to promote participation in the sharing scheme. [See Chapter 3 and Chapter 4]

1.6 Implementation Sequence

1.6.1 Stage 1 – ~~Tier~~ Level 2 ADS-B data sharing

The data services are classified into two ~~tiers~~ levels based on the nature of ATS applications:

a) ~~Tier~~ Level 1 Data Service
For supporting ATS applications which make use of shared surveillance data for aircraft separation.

b) ~~Tier~~ Level 2 Data Service
For supporting ATS applications which do not use the shared surveillance data for aircraft separation.

Given the idea of starting small and simple, it is recommended to start with ~~Tier~~ Level 2 data service considering the stringent service performance requirements for ~~Tier~~ Level 1 data service (for ATC) and the expected non-contiguous surveillance data coverage at start.

1.6.2 Stage 2– ~~Tier~~ Level 1 ADS-B data and other surveillance data sharing

Stage 2 would be at a much later stage, after lessons learned and experience gained from ADS-B data sharing in Stage 1. The implementation of stage 2 would be highly dependent on the success of Stage 1 implementation given the considerations stated in para. 1.2.1. It may be worth focusing efforts on technical implementation of data sharing by opting for a surveillance data to be shared and a sharing scheme with the least (but sometimes unavoidable) diversions to other non-technical aspects. If and when sharing of other surveillance data such as radar data is ready in future, a dedicated study group would be called for to work on the implementation details and arrangement of sharing of such and other surveillance data.

Chapter 2: INFRASTRUCTURE MODEL (TASK 2-3)

2.1 Introduction

2.1.1 The CRV is a common network infrastructure in the APAC initiated by the ICAO with a view to overcoming the existing limitations in the communications of legacy civil aviation technologies and to constructing a centralized IP-based private network infrastructure by adopting modern technology. One of its purposes is to support future high-speed aviation applications. During feasibility study stage, CRV was already identified as the SWIM-enabler under ASBU framework.

2.1.2 Since the commencement of CRV operations in 2018 for voice and AMHS applications, for its performance and reliability, it has been endorsed by States/Administrations at different meetings/forums (e.g. CRV OG and SWIM TF) that CRV as the underlying infrastructure to support SWIM. And throughout a series of studies and discussions, both CRV OG and SWIM TF agreed and concluded that CRV would be used to support SWIM.

2.1.3 The SWIM TF TOR was updated in SWIM TF/5 (2021) and endorsed by CNS SG/25 (2021) that the SWIM should be implemented **principally** over CRV.

2.2 SWIM Technical Infrastructure

2.2.1 The SWIM Infrastructure has been discussed at various ICAO meetings and conferences aiming to unify the design and implementation. In these discussions, three models of infrastructure have been identified, which are Distributed, Centralized and Hybrid.

2.2.2 A typical Distributed Model is made up of active APAC SWIM participants who host their EMS servers and services to form Global Enterprise Messaging Services (GEMS) on the CRV network while supporting local access by specific systems to publish or subscribe to SWIM data. Such a Distributed Model is illustrated in Figure 1 below. The local stakeholders, such as ANSPs, airports, airlines and MET offices will then be able to publish and subscribe SWIM data through its locally connected EMS to reach other States by the GEMS.

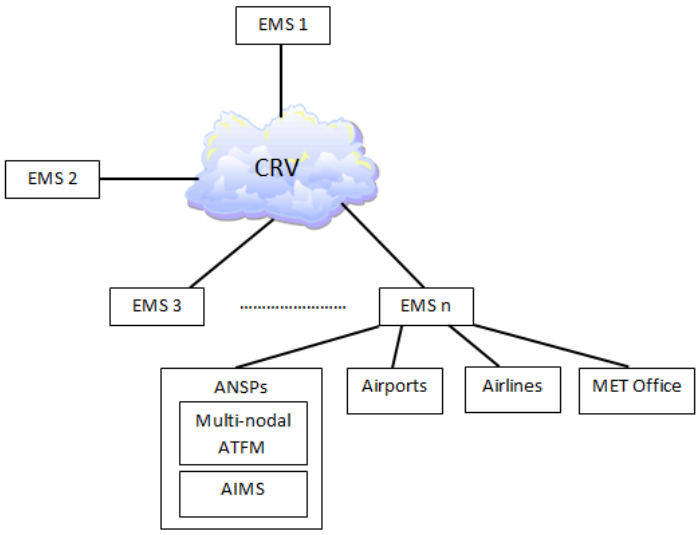


Figure 1 – "Distributed Model" of EMS services

2.2.3 In the Centralized Model, a third party may host EMS services in the CRV available to subscribers such that qualified States/Administrations/Stakeholders may subscribe or publish

SWIM data irrespective of their geographical locations but insofar as they can access to the CRV. Such a model is illustrated in Figure 2 below. Simplistically, the hosted EMS services are inside the CRV cloud.

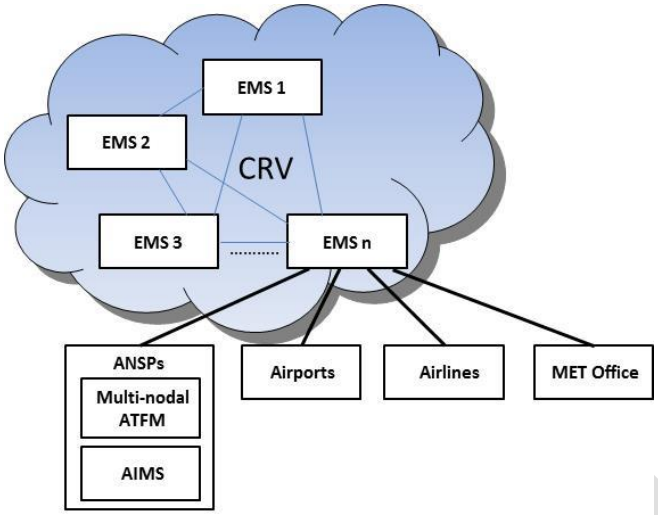


Figure 2 – "Centralized Model" of EMS services

2.2.4 In the Hybrid Model, the Distributed Model and the Centralized Model coexist, as illustrated in Figure 3 below. Simplistically, there are EMSes inside the CRV cloud (Centralized Model) and EMSes outside of the cloud (Distributed Model).

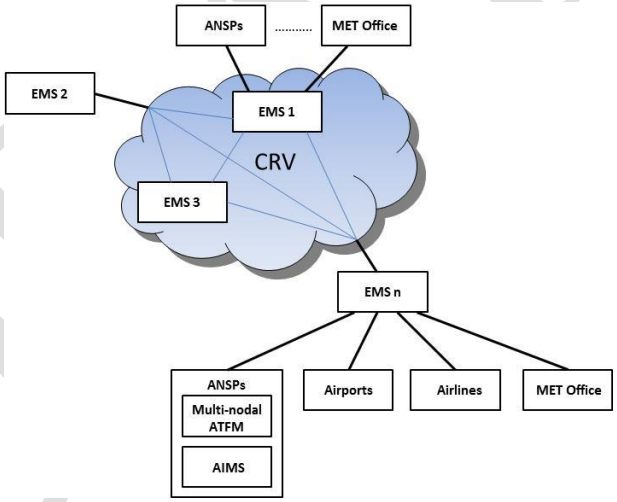


Figure 3 – "Hybrid Model"

2.3 Suggested Model for Surveillance Data Exchange

2.3.1 It is worth noting that the Hybrid Model was showcased in the ASEAN SWIM demonstration conducted in November in 2019 with successful outcome. In the demonstration, various operational information, including trajectory updates for situational awareness, aircraft turnaround for A-CDM and CTOT for ATFM Ground Delay Program was exchanged.

2.3.2 The table extracted from the report of the ASEAN SWIM Demonstration deliberating the pros and cons of different models is given as follows.

Pros	Cons
Option 1 Single EMS Architecture	
• Efficient implementation – Each participant only needs to connect once • Less metadata needed to ensure proper message routing • Faster to integrate	• Hard to get consensus on who to implement the EMS • If EMS is implemented by third party, no participant has control over how messages are routed
Option 2 Every Participant Implementing Interconnected EMS Architecture	
• Every participant is responsible for their own EMS implementation • Each participant has full control over how their EMS routes messages	• Every participant needs to establish EMS-EMS connection to every other participant, leading to point-to-point connection • Message routing is complex and less efficient, compared to Option 1
Option 3 Combined Public and Private EMS Architecture	
• Participants can decide how they wish to connect to regional SWIM, either through their own EMS or through the commercial EMS • The number of EMS being implemented is small	• Although all EMS are required to be interconnected, the complexity is still less than Option 2 • Message routing has to be agreed upon by the group that is implementing the EMSs

Note: Option 1 is considered as Centralized Model
Option 2 is considered as Distributed Model
Option 3 is considered as Hybrid Model

2.3.3 Considering that APAC members could opt for subscribing to the EMS services in CRV (if existent then) or hosting EMS servers of the own, having regard to factors such as cost, time and efforts of setup, role of data contributor/consumer, etc. as well as the successful outcome of the ASEAN SWIM Demonstration, it is suggested to also adopt the Hybrid Model in the surveillance data exchange in SWIM over CRV.

2.4 Other Elements in SWIM

2.4.1 The scope of this Study is on the sharing of surveillance data in SWIM. Implementation of information services (which includes shared surveillance data) and other elements in SWIM framework such as governance, service registry and security are under the purview of SWIM TF. Yet, the sharing of surveillance data over can be realized as a non-SWIM service and migrate to SWIM as more SWIM elements and services available as an assumption stated in para. 1.3.2.

2.5 CRV Requirements

2.5.1 The CRV service providers already provide different packages for the States/Administrations to access CRV. In particular, package D offers a flexibility for the States/Administrations to access CRV via the Internet (IP-SEC VPN), though its serviceability relies on the unpredictable reliability of the Internet connection. For both data contributors and consumers, network bandwidth should be evaluated based on their own requirements according to which ~~tier~~ level of data planned to be carried.

2.5.2 On bandwidth requirements, the bandwidth required of a data contributor depends on the number of data consumers who are directly served the data from the contributor Vs the case of centralized service which would serve the surveillance data to the subscribed data consumers, thereby reducing the bandwidth requirements of the original data contributor. An implementation of centralized service tailored for surveillance data sharing (with data repository service, processing service, conversion service and other value-added services)

would be via a Surveillance Central Data Processor (SCDP) as further elaborated in para. 2.6. At a proof-of-concept event conducted in Hong Kong in October 2018 [WP/20 of SWIM TF/3], the capability of CRV to carry SWIM data was successfully demonstrated and it was concluded that bandwidth requirement was a matter of the CRV data package subscribed. At a recent proof-of-concept exercise conducted in Hong Kong in February 2022, to demonstrate and simulate the sharing of surveillance data in SWIM over CRV, some reference figures have been obtained and tabled at Appendix X to this study report. *[Note: Appendix X currently in WIP status, to be provided once available.]*

2.6 EMS and SCDP

2.6.1 A 3rd party wishing to provide centralized surveillance data sharing service may do so by way of an SCDP, which filters and collates surveillance data feeds from data contributors and outputs user-selectable data streams as a SWIM service.

2.6.2 Whereas a centralized registry for all SWIM services might not be available in the near future, this SCDP could host the service registry and exercise any governance rules if they exist.

2.6.3 From system perspective, the SCDP will be designed with redundancy and resilience in mind to achieve high availability. And the SCDP would also be served with high-bandwidth CRV links to be able to receive and serve surveillance data to other ANSPs.

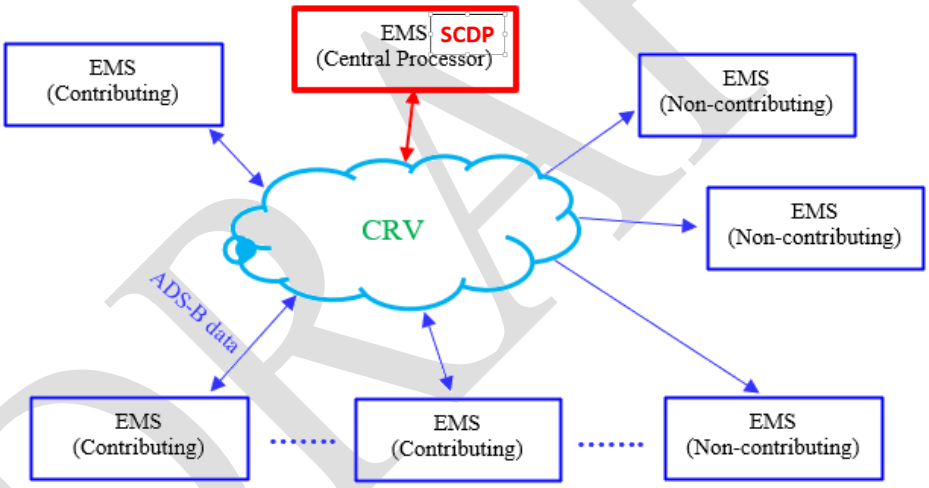


Figure 4 – Proposed Model of SCDP

2.6.4 The EMS and SCDP are to be tightly coupled regardless if they are provisioned by single service provider or not with expected advantages as follows:

a) With expected low latency and throughput in the local connection between EMS and SCDP, potential bottlenecks in data flows and processing could be eliminated, which is important and necessary since a high volume surveillance data traffic would be exchanged between EMS and SCDP internally and between EMS and other EMSes externally.

b) A closely coupled EMS and SCDP would be more reliable and clearly cost-effective services with the need for remote connection, network equipment and link costs.

c) An SCDP will also greatly alleviate the bandwidth requirements of individual data contributors who need to cater for a large number of data consumers by providing a single stream of surveillance data to the SCDP for its onward distribution to data subscribers.

Chapter 3: BUSINESS MODEL (TASK 2-4)

3.1 Responsibilities of Data Contributors

3.1.1 Service Availability & Reliability

To provide reliable data sharing service to participating users, data contributors should maintain a certain level of system availability and reliability in their surveillance data sharing service. In the initial stage, the implementation focuses on the sharing of ADS-B data. By referring to Appendix 6 "*Baseline ADS-B Service Performance Parameters*" of ICAO'S *ADS-B Implementation and Operations Guidance Document Edition 13.0 – September 2020*, ("Ref 1"), the following service parameters are recommended to be delivered by surveillance data sharing systems to support the corresponding operation mode of the data services.

Service Parameters	**~~Tier~~ Level 1 Data Services [Equivalent to Category 1 (Tier 1) under "Ref 1" to support aircraft separation]**	**~~Tier~~ Level 2 Data Services [Equivalent to Category 3 (Tier 3) under "Ref 1" to support enhanced flight operation]**
System Availability	Total Service Availability > 99.9%	Total Service Availability > 90%
System Reliability	Total Service MTBF > 50,000 hours	Total Service MTBF> 200 hours

3.1.2 Integrity of ADS-B Data

a) The Data Contributors should not modify the content of the surveillance data except for the following purposes:

   i. ASTERIX Edition upgrading or downgrading;

   ii. Format conversion to meet the agreed data format for sharing;

   iii. SAC/SIC amendment; and

   iv. Fusion of data from multiple sensors such as removal of duplicated ADS-B position reports. Any extrapolation of position reports shall not be shared.

b) Time stamp of the surveillance data report shall be based on a reliable time source without any modification by the data contributors.

3.1.3 Report Filtering

a) Screening out special or non-civilian flights (e.g. State aircraft) is allowed with the filters being agreed upon prior to implementation. The filtering mechanism shall be detailed in the data services provided.

b) For ADS-B data, the data contributors shall not perform any data filtering based on ADS-B quality indicators or blacklist. All the ADS-B data shall be shared with users as far as possible.

c) Considering that States will be making the assessment of data usability, and that lower NUC/NIC can still support lower ~~tier~~ level operations, all data should be sent without filtering based on NUC/NIC.

3.1.4 Update Intervals / Data Latency

a) With the same reference to "Ref 1" in para. 3.1.1, the following service parameters are recommended on the timeliness and data latency of the surveillance data sharing systems.

Service Parameters	**~~Tier~~ Level 1 Data Services [Equivalent to Category 1 (Tier 1) under "Ref 1" to support aircraft separation]**	**~~Tier~~ Level 2 Data Services [Equivalent to Category 3 (Tier 3) under "Ref 1" to support enhanced flight operation]**
Aircraft Updates	0.5 second < Interval <-10~~5~~ seconds	0.5 second < Interval < 60 seconds
Data Latency	95%: < 2 seconds	95%: < 60 seconds

3.1.5 Format of the data

a) ASTERIX CAT 21 Edition 2.1 is recommended for the initial implementation, as most of the States are able to support without additional data conversion efforts.

b) The SCDP would be able to provide data conversion services between different ASTERIX CAT 21 editions, to support legacy system if required.

3.2 Collaboration Model

3.2.1 Participating as Data contributors

a) Due to the varying degrees of SWIM implementation status of States, data contributors should offer flexibility to allow surveillance data sharing to the data consumers either by direct interfacing or by centralized SCDP services provided by a 3rd party.

b) Direct interfacing between data contributor and data consumer can be established regardless if there exists an SCDP. However, an SCDP is expected to greatly accelerate the implementation of surveillance data sharing and popularize its utilization in accordance with the "starting small and simple" philosophy. SWIM-enabled States can choose this collaboration model for an initial trial with a "local SCDP" and then populate the SCDP services through further collaboration in a later stage by expanding their capabilities or by way of 3rd-party SCDP centralized services.

c) Surveillance data sharing services (~~Tier~~ Level 1 and ~~Tier~~ Level 2), if offered via SCDP, require the collaboration between States (as data contributors) and the SCDP service provider for the data provision mechanism, including data format, data update rate, etc., to ensure the SCDP can deliver the ultimate surveillance data sharing services, meeting the service parameters mentioned in para.3.1.4.

d) Data charging scheme or incentives provided to States who are data contributors to the SCDP should be explored to encourage data contribution to the SCDP.

e) With the presence of SCDP, States without SWIM infrastructure can also contribute their data by legacy means and in legacy data formats (if it is the case) to the SCDP, which will

then take care of data conversion and onward data surveillance sharing service for dissemination.

3.2.2 Participating as Data consumers

a) States, based on their own SWIM implementation status, can choose between direct interfacing with the data contributor or use the surveillance data sharing service provided by SCDP.

b) States with SWIM infrastructure may participate in the initial trial by direct interfacing between data contributors, in respect to para. 3.2.1(b).

c) Data consumer without SWIM infrastructure can subscribe to the surveillance data sharing services from the SCDP to benefit from shared surveillance data.

3.2.3 Eligibility to be a data consumer

a) In para. 1.5.3, three options of participating as data consumers were explored, repeated below:

i. Option 1 - data will be shared among all the participating users;

ii. Option 2 - data contributor gets to decide who can receive its shared data;

iii. Option 3 – only data contributors can be consumers.

b) In para. 1.5.3, it was recommended that Option 1 be adopted in the spirit of sharing and benefitting the aviation community as a whole. Option 2 may be considered for some data contributors if there are specific circumstances. Option 2 nevertheless would not be conducive to quick implementation of data sharing due to a lack of across-the-board "free to use" approach which would necessitate multi-lateral agreements, more elaborate technical implementation and service governance and controls.

c) Options 1 and 2 are not mutually exclusive however. Technically, there should be no issue in implementation either or both options in the SWIM environment. Option 3 is not preferred since by nature it would require an ensemble of interested parties, all of whom necessarily data contributors, to participate. This by itself becomes a hurdle to quick implementation of surveillance data sharing and, like Option 2, goes against the spirt of data sharing.

3.3 Data Coverage

3.3.1 Considering the benefits from shared surveillance data, some possible choices on the extent and geographical coverage of data to be shared are listed below:

a) Choice 1: Data contributor to share data from all its ADS-B stations (maybe difficult for States with large FIRs);

b) Choice 2: Data contributor to share data from at least one of its ADS-B stations (the data from the chosen station may not be useful to all other States);

c) Choice 3: Data contributor to share data from all its international flights (useful for ATFM);

d) Choice 4: Data contributor to share ADS-B data from stations that are near the FIR boundaries (useful to cover surveillance gaps);

e) Choice 5: Data contributor to share data from ADS-B stations that are near airports for international flights (useful for ATFM).

3.3.2 Among the above five choices, choice 4 can support ~~Tier~~ Level 1 data service as a minimum while choice 5 can support ~~Tier~~ Level 2 service as a minimum. Therefore, it is recommended that combination of choices 4 and/or 5 be selected as a minimum for a data contributor.

3.3.3 As mentioned in para. 3.2.1(d), data contributor could be offered some incentives in using SCDP. States are thus encouraged to contribute data as much as they could, which can help build up a rich and more comprehensive set of data via the SCDP.

3.4 Operational Arrangement and Governance by an Operations Group

3.4.1 An Operations Group, such as CRV OG, might be necessary to administer and supervise the data exchange system, which would be subjected to extent of participation, commitment and 3rd party/commercial participation.

3.4.2 Preferably, the Operations Group can be established before implementation or a trial implementation to consider and manage the various issues arising.

3.4.3 The Operations Group should oversee the following:

a) Membership;

b) Administration of the agreement with 3rd party/commercial participations (if any);

c) Maintenance of the technical specifications of the surveillance data sharing platform;

d) Management of the performance of the surveillance data sharing platform, such as SLA management; and

e) Facilitation of communications among member States for the deployment and implementation status update from the States.

3.4.4 To shorten the implementation time and minimize operating costs, a bottom-up, agile approach to exchange surveillance data by leveraging CRV and adopting ASTERIX surveillance data format via some centralized and dedicated EMS and SCDP services provided by business entities and/or pioneering participants running their own EMSes to provide dedicated surveillance data sharing services should be adopted. The comprehensive governance framework under SWIM is not a necessity in the beginning of the implementation or its trial.

3.5 Financial

3.5.1 As a default, data consumers should be responsible for the cost to connect to the main sharing platform (which could be the SWIM network or SCDP). Data contributors should keep track of the user base to ensure their CRV connections are provisioned with sufficient bandwidth for uploading the data for sharing through direct connections to data consumers and/or to the SCDP. Given the expected surveillance data of other airspaces in return of the contributed

surveillance data of own airspaces, they should be able to justify the additional bandwidth requirements on the CRV connections for both contributing own and receiving other surveillance data. The States can choose to setup its own EMS for data sharing and be responsible for the cost in the initial setup and the on-going maintenance and support. Alternatively, ANSP can choose to subscribe to the commercial centralized EMSes and be responsible for the service subscription fee instead.

3.5.2 In general, there are two approaches in setting up the surveillance data sharing platform, namely On-Premise Approach and Cloud Based Approach. A comparison, including financial implication, between the two approaches are given below for States' consideration.

	On-Premise Approach		**Cloud Based Approach**	
Cost	Contributor	Consumer	Contributor	Consumer
One Time Cost (System Setup)	High	-	Low	-
System Operation & Maintenance	High	-	Nil	-
Recurrent Cost - Service Subscription	Nil	depends on Contributor	OPEX	OPEX
Network Connection for data sharing	Need to upgrade	Need to upgrade	Handled by service provider	Handled by service provider
Network Resilience	Need to upgrade	Need to upgrade	Handled by service provider	Handled by service provider
Development Efforts (Service upgrade, Security etc.)	Handled by Contributor	-	Handled by service provider	-
Control	Handled by Contributor	-	Handled by service provider based on the instructions from Contributor	-
Compliance	Handled by Contributor	-	Handled by service provider	-
Delivery Lead Time	Long	-	Short	-
Flexibility	Low	-	High	-
24x7 Trouble Shooting	Handled by Contributor	-	Handled by service provider	-

Chapter 4: PARTICIPATION MODEL (TASK 2-5)

4.1 Introduction

4.1.1 As the availability of shared surveillance data is fundamental to the successful implementation of the surveillance data sharing, this part explores and identifies a participation model to encourage participation from States and non-ANSP stakeholders as well as to promote surveillance data sharing for the good of the aviation community.

4.1.2 This part is to define obligations/eligibility of the participating users and develop a set of requirements and guidelines for participation.

4.2 Rights of Data Consumers

4.2.1 Rights to receive shared data

There are various options of eligibility to receive shared data:

a) Option 1 - data will be shared among all the participating users;

b) Option 2 - data contributor gets to decide who can receive its shared data;

c) Option 3 – only data contributors can be consumers.

Option 1 is the preferred approached as described in para. 3.2.3 and not repeated here.

4.3 Responsibility of Data Consumers

4.3.1 While data consumers benefit from the shared surveillance data, they should be encouraged to contribute surveillance data by relaying and/or providing their own as the case may be, increasing the appeal of the sharing scheme with a broader set of data and therefore greater geographical coverage. However, imposing such an obligation for sharing may not be practicable at the early stage due to the implementation complexity. It will also raise hurdles for and discourage participation initially. To be consistent with the agile approach for surveillance data sharing, it is suggested to allow more flexibility in enforcing the obligation at the early stage.

4.3.2 The obligation and eligibility should be limited to ANSPs who have data to be shared. Other members, who may not have data to share can be admitted through multilateral agreement(s) or other participation schemes with contribution in other forms, such as subscription or bearing cost of surveillance data sharing.

4.4 Safety Related Requirements

4.4.1 Despite reasonable steps taken by the data contributors to ensure the service availability and reliability, the data consumers, being the users of the shared data, shall be responsible for:

a) assessing the surveillance data received to decide whether it is suitable for use; and

b) provision of contingency plan(s) in case of interruption of data sharing service.

4.5 Memberships

4.5.1 Members could comprise ANSPs of ICAO APAC States, airlines, airport operators and aviation service providers. It is beneficial to include as many members in the industry as possible to build up a user base for sharing, support and collaboration.

4.5.2 For members who may not be able to contribute surveillance data (such as airlines), they could either be provided with secure connections to their respective ANSPs' EMSes or directly subscribe to the services from SWIM surveillance data service providers for accessing the surveillance data shared. They could contribute by subscription or other forms.

4.5.3 Requirements/Guidelines for Qualification of Membership

To support the fundamental consideration of encouraging participation, it is recommended that membership be simple and straightforward. By default, all ICAO APAC States/Administrations qualify as members subject to signing a multilateral agreement to demonstrate and commit to:

a) the compliance with the membership obligations; and

b) adherence to the rules, standards and guidance.

For other stakeholders, membership is to be determined by the Operations Group. Regular review/renewal of membership is recommended to ensure the continuous compliance with the obligations and rules that might be adjusted over time.

Chapter 5: IMPLEMENTATION ROADMAP AND TIMEFRAME (TASK 2-6)

5.1 Introduction

5.1.1 This paper presents a proposed implementation roadmap and time frames for surveillance data sharing in SWIM over CRV, with consideration of approach, types of surveillance data and information exchange model.

5.1.2 This study report is to be delivered as a deliverable in the feasibility study stage for SURSG's consideration and facilitate the preparation in later recommendation stage.

5.2 Implementation Roadmap

5.2.1 Development of CONOPS

A proposed concept of operations (CONOPS) for surveillance data sharing in SWIM has been developed by Singapore, Hong Kong China, Thailand and Vietnam. A comprehensive discussion has been included, ranging from practical models for collaboration and operation to business models by taking into account available platform(s) and other technical considerations.

5.2.2 Development of different models

Based on the CONOPS, it is required to study, identify and recommend practical models for specific subject matters including implementation model, infrastructure model, business model and participation model. In order to facilitate the sharing of surveillance data, it is essential to have a certain level of details recommended in the developing models. The models covered in Chapter 1 – 4 foresee the potential issues/concerns to be encountered and suggest way forward.

5.2.3 Preparation of guidance material and multilateral agreement

a) With reference to the models and recommendations advised in this Study Report to be adopted by SURSG/2 meeting, guidance material, specified system requirements, performance requirements, operation and maintenance practice and so forth, should be developed to facilitate and harmonize the implementation of surveillance data sharing. The guidance material should also provide guidance for design, testing and commissioning of the system for surveillance data sharing to ensure coherent system development.

b) Multilateral agreement may involve a lengthy negotiation process, depending on size of participant group and agendas. Despite considerable time it may take, multilateral agreement is considered a more suitable option over bilateral agreement in order to attain non-discrimination data sharing with transparent, fair and equitable treatment.

5.2.4 Implementation of infrastructure – SWIM, CRV and EMS

SWIM over CRV is the default means to share surveillance data. Different SWIM infrastructure models may be adopted by different States and members, namely Distributed (with locally connected EMS), Centralized (with centralized EMS in CRV) and Hybrid. The Hybrid Model is considered the most suitable one with maximum efficiency and minimal geopolitical concerns. The members are suggested to evaluate and determine which infrastructure models to adopt based on their own context. The infrastructure should be implemented according to the requirements set out with considerations of latency, throughput, network security, system reliability and cost effectiveness.

5.2.5 Implementation of information service – software development, functional test and functional validation

It is envisaged that information service developed based on the functional and performance requirements, such as message format and data filtering, will be properly tested and validated locally or with the adjacent regions so as to ensure a reliable system for surveillance data sharing.

5.2.6 Operational test, validation user acceptance and operation deployment

Upon the completion of the implementation of infrastructure and information service, the overall functions of sharing of surveillance data could be verified through operational test and user acceptance test. Member's involvement in this stage is important to identify system deficiencies or interface issues, if any, for further investigation and improvement before putting into operation.

With the comprehensive testing and review over the system, it would be ready to deploy for operation. Regular meetings across the States should be held with an operations group to review the performance and examine issues found, if any. Collaborative review process and cooperative system fine-tune will be crucial for the continuous improvement and further development of surveillance data sharing.

5.3 Approach

5.3.1 As advised by SURSG/1 – WP05, the bottom-up, agile-like approach adopted for APAC SWIM implementation should be adopted for surveillance data sharing in SWIM to align the philosophy and roadmap for both. It is easier to deploy multiple and incremental approaches to build up capabilities to share the data.

5.3.2 The incremental approach is to start small and simple, identifying and selecting one particular operation for implementation of surveillance data sharing, followed by identification and implementation of information services and infrastructure services required to support the operation.

5.3.3 This bottom-up approach will help to justify the implementation of the infrastructure needed to efficiently support the operations. Once the advantages of the surveillance data service are revealed after the first operation, the same process can be applied to other operations considered suitable.

5.4 Type of Surveillance Data Shared

5.4.1 Considering the mature experience of States in sharing ADS-B data and little concern over data ownership, it is proposed that the sharing of ADS-B data should be focused in the initial implementation stage.

5.4.2 However, the sharing of surveillance data is not limited to ADS-B. With the experience obtained from ADS-B data sharing, adjustment/fine-tine could be made, where considered necessary, on various aspects including the implementation platform, exchange model, business model and so forth to accommodate the sharing of other types of surveillance data.

5.5 Information Exchange Model

5.5.1 It is envisaged that the data will be used by the existing surveillance data processors. Unified data format ASTERIX CAT 21 edition 2.1 is recommended to facilitate the use of surveillance data shared.

5.5.2 While SWIM over CRV is the default means to share surveillance data, there are three SWIM infrastructure models recommended: Distributed Model, Centralized Model and Hybrid Model. To align with the principle, starting small and simple, Hybrid Model is considered the best suitable solution as it makes a good balance between maximum efficiency and geopolitical concerns.

5.6 Collaboration Agreement

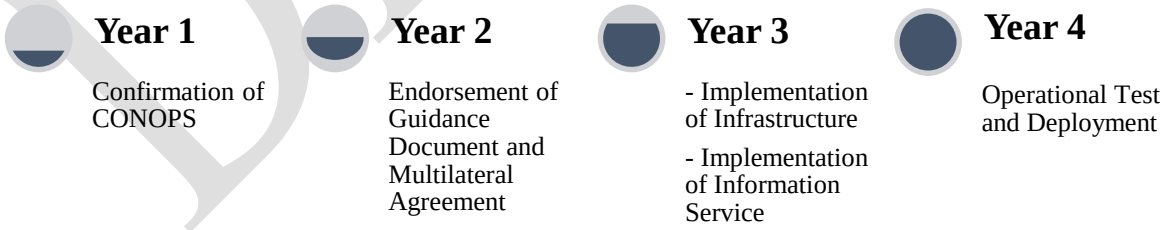
5.6.1 Bilateral agreement is relatively easy to go into effect as only two countries are involved in the negotiation. Nevertheless, it may result in exclusive deals which are against the vision of surveillance data sharing. Some willing participating ANSPs with less data may be unfavorable compared to those possessing key surveillance data.

5.6.2 In contrast, despite the complex negotiation and significant effort required, multilateral agreement allows for an equal and transparent arrangement for surveillance data sharing, which definitely encourages active participation and promotes collaborative surveillance data sharing. The value of the sharing could be recognized with a certain extent of participation.

5.6.3 With the above considerations, multilateral agreement, rather than bilateral agreement, is recommended to standardize the terms and conditions among the participating States/parties and achieve an equal playing field.

5.7 Timeframe

5.7.1 The implementation timeline places the tasks identified in the implementation roadmap proposed in para. 5.1 in chronological order. The implementation timeline may differ to certain extent, depending on the actual deployment model and approach. The implementation of SWIM platform is definitely a key contributing factor to the timeline of surveillance data sharing.



5.8 Trial Implementation of Surveillance Data Sharing in SWIM

5.8.1 It is known that some states are already sharing surveillance data through direct peer-to-peer connections. There does not appear to be technical issues in the sharing surveillance data in the SWIM environment. It is also known that status of SWIM implementation among states/administrations varies. There could be mismatched resources where those with data to contribute or to receive might not have ready access to a SWIM platform to participate in the

trial. To quickly build up a sizable participant base with reasonable breadth of shared surveillance data, some participant(s) with EMSes would need to share their data to quite a number of data consumers, with cost implication of bandwidth and system management even if service performance levels need not apply in the trial as mentioned in para. 1.5.2.3.

5.8.2 Pioneering participant(s) with EMS(es) might not be willing to take up the efforts of establishing, shouldering responsibilities and costs of such a trial, whereas a 3rd party/commercial concern might be willing to and with SCDP and value-added services provided as well except that commercial considerations would be its paramount consideration. Yet 3rd party/commercial participation has the clear advantage in its ability to significant accelerate the trial implementation.

5.8.3 It is therefore worth considering that the trial implementation of surveillance data sharing over SWIM a rudimentary one with the minimal SWIM services, regardless if there is 3rd party/commercial participation instead of a full-fledge implementation in line with the starting simple and small principle and to minimize participants' financial commitment.

5.8.4 By the two POCs in October 2018 and February 2022, there is not much doubt of the feasibility of surveillance data sharing in SWIM over CRV. The trial, if implemented, is not to demonstrate such feasibility in a one-off event, but to showcase, as an ongoing effort, the user benefits and to form the model on which continuous enhancements are to be applied as lessons are learned and experience gained. Whether a trial implementation would precede the implementation proper would be a subject of discussion at CRV OG and SWIM TF meetings.

Chapter 6: High-Level Summary of Recommendations

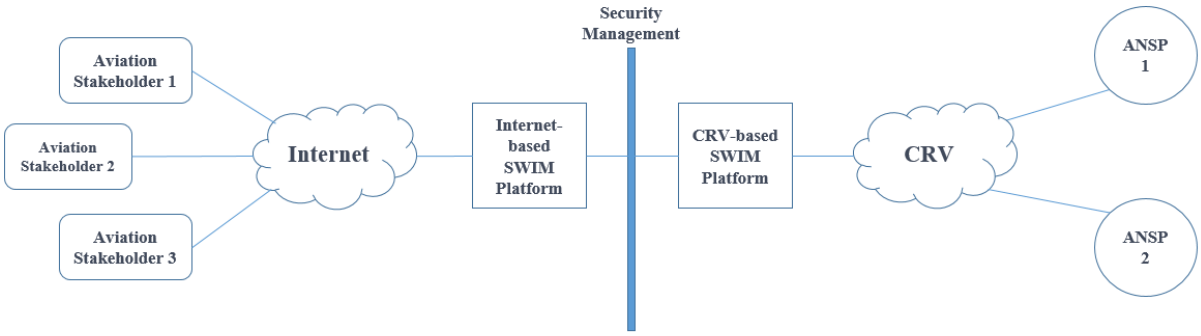


Figure 5 – Different Connectivity Options

6.1 A proposed and full implementation of surveillance data sharing using SWIM platform is depicted in Figure 5 showing one 3rd party/commercial interest providing the centralized services. The core network to be used will be riding on the CRV (right side of the diagram), which surveillance data exchange among ANSPs takes place under a secured and SLA guaranteed environment, to ensure necessary performance parameters can be achieved, to fulfil the required operational needs (i.e. ~~Tier~~ Level 1 Data Service).

6.2 Stakeholders that are currently not under the coverage of CRV can subscribe to the surveillance data sharing service (whether it is under the CRV network or not) through the internet-based platform (left side of the diagram), by various connection means. With proper security management, the internet-based platform will be able to communicate with the CRV network and allow surveillance data exchange between the two platforms. This type of connection will be feasible for applications that are not time critical (i.e. ~~Tier~~ Level 2 Data Service), as the SLA brought by the internet-based platform is not guaranteed.

6.3 With the analysis over different models in this Study Report, it has been repeatedly suggested that the principle of starting small and simple is the fundamental principle for the implementation of surveillance data sharing. For quick implementation of surveillance data sharing, it is highly recommend to have the following engagement as far as possible:

a) 3rd party/commercial participation to provide centralized SCDP services;

b) Start off the implementation with a trial; and

c) Early establishment of Operations Group.