CAAS’ Approach to ATM Modernisation

Civil Aviation Authority of Singapore
ICAO Seamless ATM Symposium & Ad-hoc Group Meeting
15 to 17 Aug 2011
### Increasing Difficulties in ATM

| Lack of predictability of traffic | • Under-utilization of technology for air-ground information sharing  
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<th>• Non-uniform fleet equippage</th>
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| Airspace congestion              | • Traffic growth  
|                                  | • Airways complexity  
|                                  | • Rigid airspace |
| High ATC workload                | • Constant control of air traffic through RT  
|                                  | • Tactical manoeuvring of aircraft |
| Ground complexity                | • Aerodrome congestion  
|                                  | • Taxiing and pushback inefficiency  
|                                  | • Key ATM stakeholders working in isolation |

Compounding ATM problems
Need for ATM Masterplan

Compounding ATM problems + High projected traffic growth + Increasingly complex and sophisticated airspace situations + New technologies that enable revolutionary changes in ATM

Need for longer term planning to put in place appropriate ATM capabilities and measures
Future ATM Operational Concepts

ICAO Doc 9854 ATM concept components

1) AOM – Airspace Organisation and Management
2) DCB – Demand / Capacity Balancing
3) AO – Aerodrome Operations
4) TS – Traffic Synchronisation
5) CM – Conflict Management
6) AUO – Airspace User Operations
7) ATM SDM – ATM Service Delivery Management

Utilising ICAO concept components, groups of potential improvement areas were identified and further refined into future operational concepts which form the basis underpinning our future ATM system.
**Future ATM Operational Concepts**

### Flexibility of Airspace
- Current: Rigid Airspace
- Optimize usage by civilian and military aircraft
- Allow last-min changes in flight paths and levels and to minimise effect of adverse weather on ops
- Quick change to airspace configurations to suit fast-changing demands

### Separation Management
- Current: Tactical Control by ATC
- Early resolution of potential conflict
- Advanced advisory tools
- Elements of self separation
- Ability to react swiftly to abnormal circumstances
- Predetermined trajectory separation

### Trajectory Based Operation
- Current: Fixed Airways
- High predictability of aircraft tracking and pilots’ intention
- Accurate aircraft navigation in 4 dimensions – time & 3 spatial dimensions
- Optimum and flight profiles
- Maximize efficiency and minimize delay
Future ATM Operational Concepts

**Ground Movement Synchronization**
- Current: Manual taxiing and pushback coordination, decreasing efficiency with traffic growth
- Automatic generation of taxiing plans
- Linkage of taxiway lightings with taxiing plans
- Seamless transmission of taxi plans to pilots
- Synchronized air and ground movements
- Early detection and prevention of ground conflict

**Optimal Human Performance**
- Current: High ATC workload due to constant control of traffic through RT
- Intuitive Human-Machine-Interface (HMI) to reduce steep learning curve of controllers
- Reduce routine tasks with automation
- Reduce error-prone controller-pilot Radio Telephony (RT) exchanges
- Traffic monitoring rather than tactical control

**Information Sharing**
- Current: Each stakeholder makes decisions in isolation and without full information
- Common picture of traffic situation and weather for all stakeholder for decision making
- Full spectrum of information exchange between air-to-air, air-to-ground, and ground-to-ground
- Timely updates of information for all concerned parties
ATM Operational Requirements

Future ATM System Operational Concepts

General
- Situational Awareness
- Conflict Management
- SWIM
- Enhanced Controller Performance

Airspace
- Enroute Management
- Terminal Area Efficiency
- Trajectory Management

Ground / Airport
- Surface Traffic Management
- Runway Optimisation
Phases in ATM Masterplan

- **Near Term (Till 2015)**
  - Define future system requirements.
  - Implement ongoing projects and new but matured solutions to address immediate needs.

- **Mid Term (2016 - 2024)**
  - Develop new solutions.
  - Customise new systems for deployment. Review requirements.

- **Long Term (& beyond)**
  - Harvest development projects for deployment to satisfy long term ATM goals.
Near Term Improvements
Near Term Improvements

Situational Awareness
- VHMS III
- MSTS
- ADS-B (Out)

Surface Traffic Management
- ALCMS
- A-CDM
- DMAN
- A-SMGCS Phase II

Runway Optimisation
- Reduce Runway Occupancy Time
- Independent mixed mode

Terminal Area Efficiency
- Internal PBN Capability
- Terminal Airspace Capacity Study
- RNAV1 SIDS/STARS

Enroute Management
- AIDC
- ATM CDM
- RNP4

Trajectory Management
- CDO
- ASPIRE - Daily
- Enhanced Changi Flow Management

Conflict Management
- STCA in Approach
- MTCD
- PTI

Enhanced Controller Performance
- LORADS III ATC System (Java HMI, LOS, eStrips etc)

System Wide Information Management
- AIM
**ADS-B (Out)**

*Ops Requirement – Situational Awareness*

- New surveillance concept which complements radar
- ADS-B stations pick up data, relating to identities, positions and altitudes etc, at regular intervals and relay them back to ATC Centre
**ADS-B (Out)**

**Ops Requirement – Situational Awareness**

- Collaboration Project Phase 1 – Singapore is working with Indonesia and Viet Nam to benefit ATS routes L642 and M771
Vessel Height Measurement System (VHMS)-III

**Ops Requirement** – Situational Awareness

- Used to provide detection, tracking and height measurement of passing vessels in the Traffic Information Area (TIA) of East Johor Straits
- Warn off any hazards to low flying aircraft approaching and departing Singapore Changi Airport
VHMS-III Surveillance Coverage

*Ops Requirement – Situational Awareness*
LORADS III ATC System

**Ops Requirement – Enhanced Controller Performance**

- Decision Support Aids (e.g. HAM)
- Improved workflow with Java HMI, e-Strip

*e-Strip / stripbay*
LORADS III ATC System

*Ops Requirement – Enhanced Controller Performance*

- Enhanced Safety Nets (e.g. Enhanced STCA, MTCD)

### Enhanced STCA with Multiple-Hypotheses

The main hypothesis is composed of a straight line, followed by a **circular prediction** limited by a heading intent and followed by a straight line prediction.

- **Normal track prediction indicating violation of separation.**
- **Reduced Separation apply.**
- **Predicted separation at Look Ahead Time 2H**
- **Look Ahead Time 2H (straight)**
- **Look Ahead Time (with Turn)**
- **Look Ahead Time (with Turn)**
- **Track prediction with turn intent.**
- **Standard Separation becomes applicable**

Diagram showing aircraft trajectories and separation criteria.
LORADS III ATC System

**Ops Requirement** – *Enhanced Controller Performance*

- MSTS – fusing of multiple surveillance sources
- Level Of Service (LOS) Symbology
Aeronautical Information Management (AIM) System

**Ops Requirement – System Wide Information Management**

![Diagram of Aeronautical Information Management System](image-url)
Mid Term Improvements
Mid to Long Term Improvements

• Mid to Long Term improvements are still work in progress as we continue to refine our ATM capability requirements. In doing so, CAAS look to trends of emerging technologies and ATM best practices which will be useful and consider early adoption. At the same time, we continue to refine our requirements and plan for possible development of future systems.

• For the Mid Term, PBN has been identified as a key enabler to several improvement areas, especially Terminal Area Efficiency and Trajectory Management. PBN will be utilised to optimise airspace as well as improve flight operational efficiencies.

• Examples of planned improvements for the Mid Term include:
  - GBAS Landing System (GLS)
  - RNP AR approaches
  - RNP-GLS pairing
RNP and GLS

**Ops Requirement – Terminal Area Efficiency**

- GLS or GBAS Landing System – ILS-like but with greater operational flexibility
- It is like switching from Analogue TV to Digital TV
- Combining RNP with xLS (ILS or GLS) yields a powerful solution of precision approach with curved final approach path
Study on Atmospheric Impact to GNSS Signals

• The Singapore FIR is largely oceanic. As such, GNSS comes as a natural sensor choice for PBN implementations. GNSS is suitable for all phases of flight and it is convenient. However, there is a need to understand its long term reliability as it is susceptible to solar storms and atmospheric activities.

• Studies have been conducted on such effects on GNSS signals but little is known of the effects in the equatorial region. CAAS will be carrying out ionosphere study to find out more about such effects and the implications on GNSS applications, e.g. GBAS.
Greater ionospheric plasma density around ±20° magnetic latitude!
Implication on GBAS

Max Iono Delay happens during Solar Maximum.

Therefore, maximum Iono Delay need to be determined to ensure safe implementation of GBAS in Singapore.
CAAS is developing a GPS monitoring system with ultimate objectives to achieve:

- Real time monitoring capability
- Record GNSS data to support GNSS-based operations
- Ionospheric Monitoring and Analysis to develop mitigation measures
Global Harmonisation
Global Harmonisation

- ICAO’s vision of a globally interoperable ATM system sets the target for States / ANSPs / Industries and all other key stakeholders to work towards common ATM goals.

- At regional / sub-regional level, partners need to work together to achieve greater benefits such as from cross-border enroute capacity and efficiency enhancements. Without cross-border cooperation, States / ANSPs ATM modernisation programmes may not yield full benefits.

- As we embark on our ATM modernisation, we recognise the need to be cognisant of international initiatives such as SESAR and NextGen and to keep abreast of technological developments. As such, CAAS sees GANIS in Sept and ANC/12 as important milestones to help us align our ATM modernisation programme and to achieve interoperability with other ATM systems.
Thank You