The Remote and Virtual Tower

Fabio Massacci, Alessandra Tedeschi
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Airspace Categories & Air Traffic Service Units

- **CTA** – Control Area: Space large enough to contain airways, or part of them, in order to provide ATC service to aircrafts.
- **TMA/CTR** – Terminal Control Area: When a CTA has heavy density of traffic and it is closed to a big airport, it is called TMA.
- **TMA/APP** – Terminal/Approach: ATC unit responsible for arriving and departing controlled flights.
- **ATZ** – An airspace of defined dimensions established around an aerodrome for the protection of aerodrome traffic.
- **TWR** – Control Tower: ATC Unit responsible for the airport traffic, landing, taxing and departing.
- **ACC** – Area Control Centre: ATC unit established to provide ATC service to controlled flights in CTAs under its jurisdiction.
The Area Control Centers

Area Control Centers (ACC) manage Airspace and Terminal Areas.

- Complex web of automated equipment for
  - presentation of the air traffic (Radars)
  - traffic forecast (specific databases)
  - other information helpful for flight management (e.g. weather information)

- Airspace is organised into adjacent volumes (Sectors).
- Each Sector is operated by two Air Traffic Controllers,

- Each ACC is linked through dedicated radio frequencies to all aircrafts flying in its airspace and through dedicated point to point telephone line or radio link with adjacent ATC Units.

The Air Traffic Control Tower

- The Tower (TWR) provides ATC service to aerodrome traffic (ICAO Doc. 4444)
- TWR area of responsibility:
  - Maneuvering Area
  - Airspace around the airport, within a 5 miles radius, up to 3000 feet altitude.
- TWR authorises movement inside the airport to prevent collisions of
  - any person,
  - vehicle
  - or aircraft.
- TWR has a central position to observe and manage
  - all flights
  - and depended operations on and around airport.
Current Tower Operations (1/3)

✓ Small Control Tower could have 1 ATCOs and 1 MET operator, tower of bigger airports up to 10 ATCOs with different roles:
  – DELIVERY: in charge of giving to the A/C the permission to start-up and the departure clearances
  – GND CONTROLLER is responsible for the safety of aircraft that are taxing from and/or to the RWY
  – TWR CONTROLLER is responsible to ensure that sufficient runway separation is kept between landing and departing aircraft
  – COORDINATOR: responsible for co-ordinate arrivals according to the decisions of the Approach Control Unit.
  – SUPERVISOR: supervises the operational team and the equipment

Current Tower Operations (2/3)

✓ Current Tower Operations are mainly based on the “out-the-window” (OTW) view:
  – The OTW view is from a single viewpoint, typically high above the ground from the centre of the airport.
✓ All ATCOs “sensorial” experiences are relevant to detect potential safety problems:
  – Airport sound like engine noise, birdsong, wind noises are directly available through ambient noise.
Current Tower Operations (3/3)

- Additional systems that are needed to provide the service are:
  - Voice communications;
  - Flight Plan and ATS message handling;
  - Manoeuvring of airport lights, navigation aids, ILS, alarm and other airport systems;
  - Binoculars, Signal Light Gun;
  - Paper Strips;
- Additional tools providing information gathered through specific sensors, e.g. ground radar information, meteo radar and meteo sensor information, ADS-B data, etc. can be used to facilitate surveillance, subject to coverage.

Current Problems

- **Cost**: A main proportion of the ATS costs are associated with the building, maintenance and upkeep of the physical ATS facilities
  - maintenance and upkeep of old Tower facilities can be inefficient and expensive
  - building new towers is very expensive, compared to “ordinary” buildings
- and the costs of personnel to provide the ATS.
  - Minimum number of personnel can be costly for rarely used airports
- **No standardization**: systems, equipment, operating methods and procedures varies according to airport. This has an impact on
  - cost (equipment, systems)
  - controller training (methods, equipment and procedures).
  - Variability and subsequent controller training (and geography) → many staff will only be valid/rated for one local airport
- **Lack of space**: There is often a lack of space to install new equipments and it is impossible to build completely new Towers.
The Remote and Virtual Tower (1/3)

- The main objective of the Remote and Virtual Tower concept is to provide the air traffic services already provided by local aerodrome control Towers, but to do so from a remote location.

The Remote and Virtual Tower (2/3)

- ATCO no longer located at aerodrome
  - re-located to a Remote Tower Centre (RTC).
- RTC contains many Remote Tower Modules (RTM),
  - similar to Sector positions in ACC.
  - Each tower module remotely connected to 1+ airport
  - Each airport remotely connected to 1 or several RTM, dependent on size of airport.
- Visual surveillance provided by “reproduction” of the OTW view by
  - Option 1: remotely provided through direct visual capture and visual reproduction by cameras
  - Option 2: remotely provided through computer generated images of the aerodrome, aircraft and vehicles, and terrain mapping and computer modelling to represent aerodromes.
  - Combination of the above.
The Remote and Virtual Tower (3/3)

- Visual reproduction overlaid with information from additional sources
  - surface movement radar, surveillance radar,
  - ADS-B,
  - multilateration or other positioning and surveillance implementations.
- Technology must enhance visual reproduction in all visibility conditions
  - i.e. fog, bad weather
- Improve Situational Awareness
  - Advanced Visual Features to aid in providing separations (from other aircraft or terrain)
  - audible background sounds could be captured and relayed in the RTM.

RVT Deployment Scenarios

- A Remote Tower Centre will provide ATS for N>>1 aerodromes.
  - staff resources and RTMs will be co-located in the RTC.
  - RTC may be located far from any airport or it may be an additional facility co-located with a local facility at a (big) aerodrome
- Remote Provision of ATS for a Single Aerodrome will be applied to
  - low density aerodromes (where low density is determined as being mostly single operations, rarely exceeding two simultaneous movements)
  - medium density aerodromes (where more than two simultaneous movements can be expected).
  - small airports with occasionally more traffic density (for example tourist airports/remote airports during a particular event etc.)
  - NO big airports
- This scenario differ consistently from current operations: ATS are not currently provided to multiple aerodromes by a single ATCO.
RVT Technical Architecture

RVT Functional View
What can go wrong?

- Tenerife: 1977
  - two Boeing 747 crashed on the runway → 583 dead
  - Small airport suddenly crowded because of bomb alarm on nearby big airport
  - Fog plus “hurry” of captain to leave the airport
- Linate: 2001
  - Boeing MD-87 crashed with Cessna 525-A → all occupants + 4 ground staff
  - Low visibility plus new radar not installed due to management/cost issues
  - Wrong structure of accountability → previous «almost incidents» ignored and little training of controllers
- Uberlingen: 2002
  - Boeing 767 and Tupolov TU164M crashed mid-air → 71 dead
  - System was going over an upgrade
  - ATCO told pilots to ignore collision warnings from system plus 1 ATCO went to rest
  - Wrong structure of accountability again

Most Likely Causes?

- Study of 114 major Accident in US and Canada till 2004
  - By Cause = how many times the particular cause is mentioned over all reports
  - By report = how many reports mention the particular cause among one(s) responsible for the incident

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<th>Category</th>
<th>By Cause</th>
<th>By Report</th>
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<tbody>
<tr>
<td>Individuals</td>
<td>40%</td>
<td>60%</td>
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<tr>
<td>Organizations</td>
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<tr>
<td>Equipment</td>
<td>&lt;20%</td>
<td>&lt;40%</td>
</tr>
<tr>
<td>Other</td>
<td>XX</td>
<td>XX</td>
</tr>
</tbody>
</table>

- Guess: <10%, 20%, 40%, 60%, 80%
Some Myths

✓ Personal Invulnerability:
  – Accidents only happen to incompetent people, or to systems or equipment designed by incompetent people
    • “accidents only happen when someone messes up, and I will not mess up, so no accidents will happen to me or the systems with which I work.”
  – Because few engineers consider themselves to be incompetent, they are inclined to think that accidents will not happen to them or to the systems with which they are involved.

✓ Causal Simplicity:
  – making causal determinations for most accidents is a fairly simple thing to do

✓ Blaming an Individual:
  – 75% [or some other high percentage] of accidents are blamed on human error

✓ See Chris Johnson’s paper
  – “Why System Safety Professionals Should Read Accident Reports”

Most Likely Causes?

✓ Study of 114 major Accident in US and Canada
  – By Cause = how many time the particular cause is mentioned over all reports
  – By report = how many reports mention the particular cause among the many responsible for the incident

✓ Category By Cause By Report
  – Individuals 31% 62%
  – Organizations 50% 80%
  – Equipment 16% 43%
  – Other 3% 10%
RTV «Bad guys» scenarios?

- Global terrorist attack?
  - Global attack style 9/11
  - Not necessarily on loss of life: «Syrian Cyber Army» might claim «We grounded all European planes»
- «Local» terrorist/organized crime attack
  - Plane brought down to hit individual passengers
- Organized crime
  - Drug smuggling?
- Disgruntled Employee
- Other?
  - Unmanned Aircrafts?

RVT Security Risk Assessment

- From SESAR’s Security Case:
- The ROT concept should encompass:
  - data continuous availability and integrity to ensure safety during landing/departure and taxing,
  - data protection to ensure confidentiality and avoid malicious exploitation of traffic data,
  - physical security issues, like the on-site protection of the remotely located cameras, sensors and surveillance radars in the aerodrome, etc.