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The Remote and Virtual Tower

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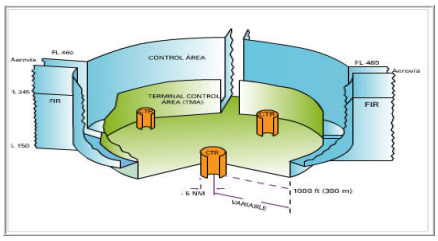
Airspace Categories & Air Traffic Service Units



CTA – Control Area: Space large enough to contain airways, or part of them, in order to provide ATC service to aircrafts

ACC – Area Control Centre: ATC unit established to provide ATC service to controlled flights in CTAs under its jurisdiction

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

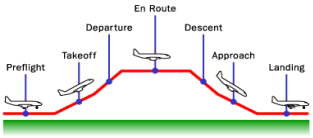
TMA/APP – Terminal/Approach: ATC unit responsible for arriving and departing controlled flights

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.

The Area Control Centers

- ✓ Area Control Centers (ACC) manage Airpsace 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.



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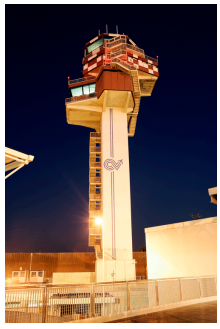
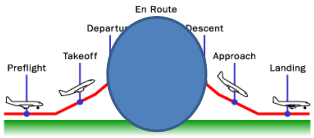
The Air Traffic Control Tower

- ✓ 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.





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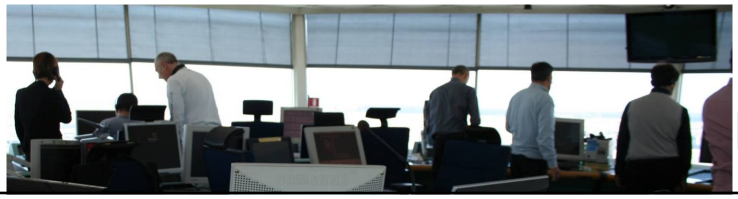
Current Tower Operations (1/3)

- ✓ 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



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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.

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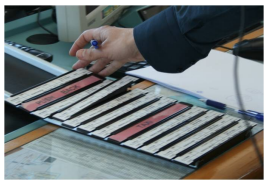
Current Tower Operations (3/3)

- ✓ 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.



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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.

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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.

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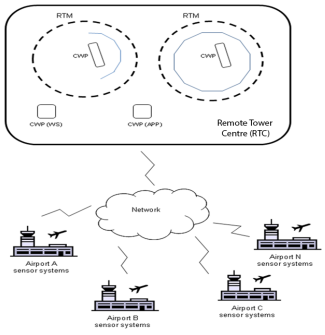
The Remote and Virtual Tower (2/3)

- ✓ 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.



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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.

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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.

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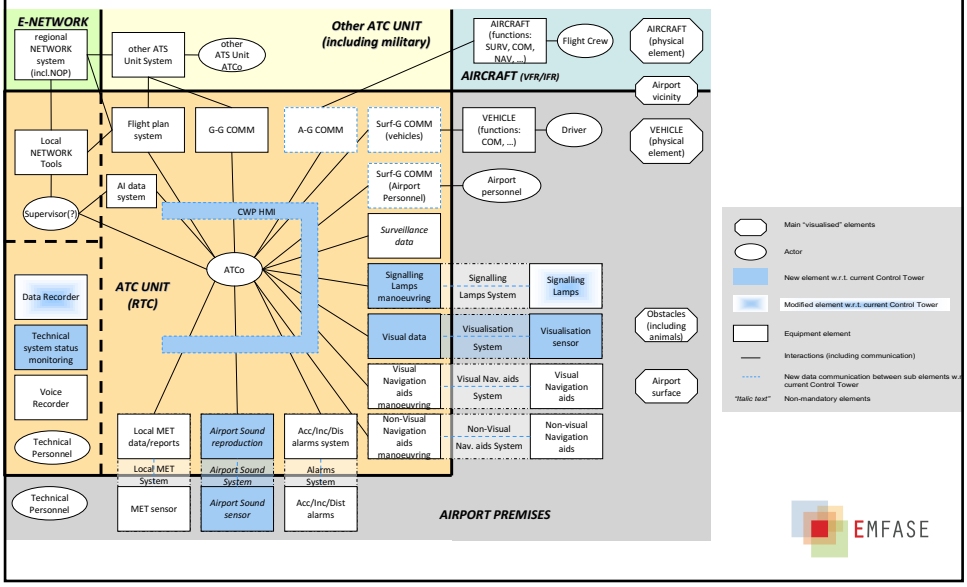
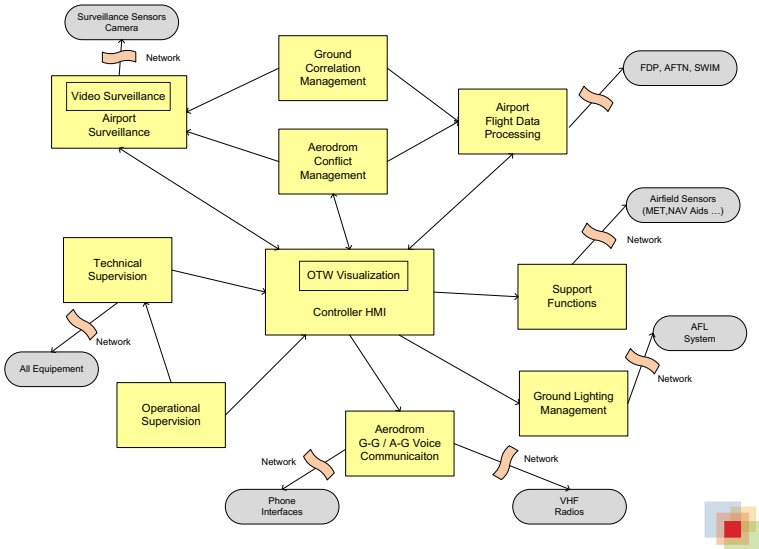
RVT Technical Architecture



RVT Functional View



What can go wrong?

- ✓ Tenerife: 1977
  - two Boeing 747 crashed on the runaway→ 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 controlers
- ✓ 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
- ✓ http://www.dcs.gla.ac.uk/~johnson/papers/Linate/Chris_W_Johnson_Ueberlingen_Linate.pdf

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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

✓ Category	By Cause	By Report
– Individuals	40%	60'%
– Organizations	20%	30%
– Equipment	<20%	<40%
– Other	XX	XX

- ✓ Guess: <10%, 20%, 40%, 60%, 80%

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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"

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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%

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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?

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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.

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