ACME-Flying Use Case

Contents

- Domain characteristics
- Data sources
- Analytical software

DOMAIN CHARACTERISTICS

Company characteristics

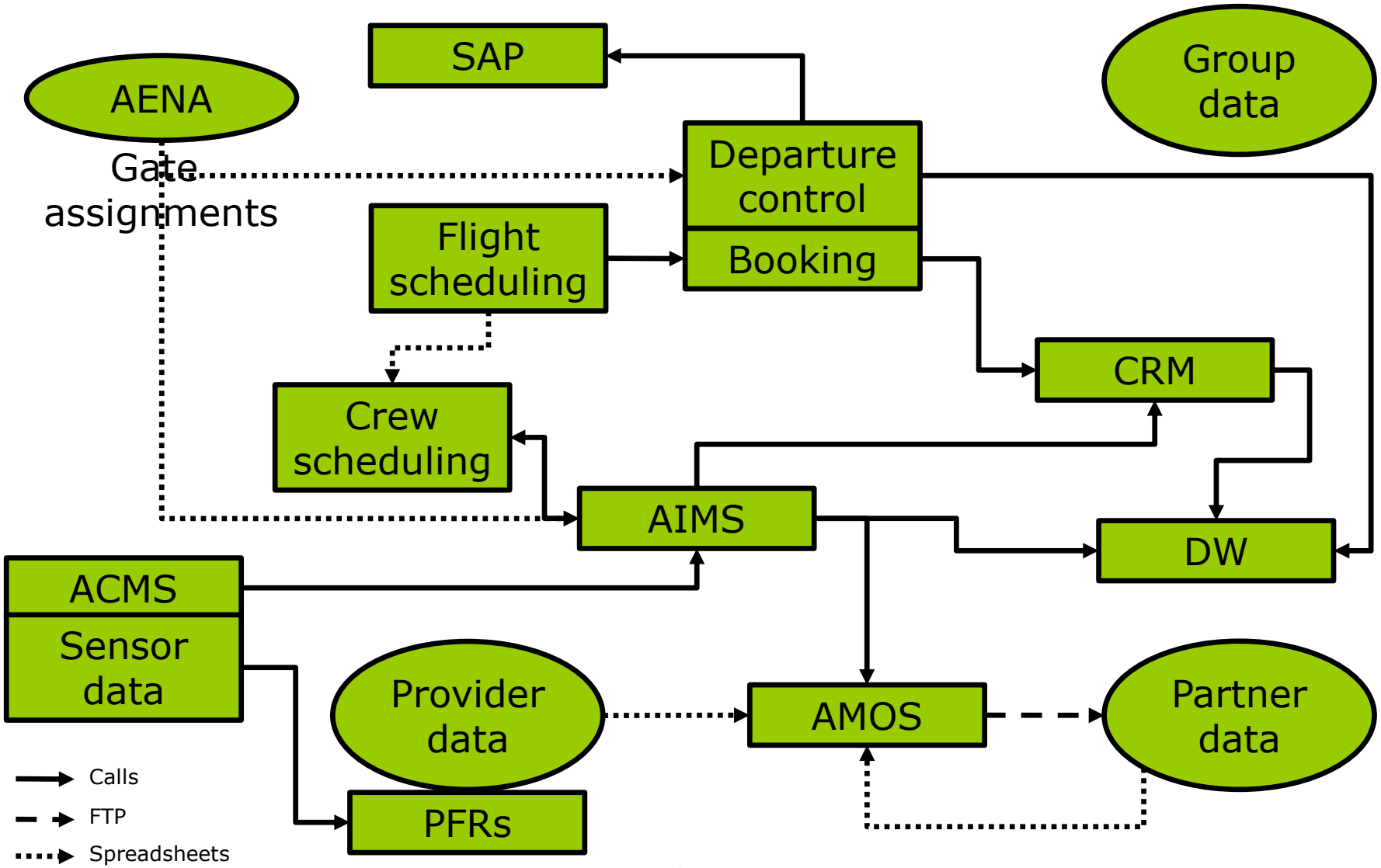
- Planes: 125
- Destinations: 120
- Flights:
  - Per day: ~700
  - Per year: ~300.000
- Post-Flight Report events
  - Per year: ~1.000.000
- Maintenance events:
  - Per year: ~13.000
    - ~10.000 Delays (non-programmed short)
    - ~2.400 Aircraft On Ground (non-programmed long)
    - ~350 Maintenance (programmed short)
    - ~100 Revision (programmed long)

Difficulties of the analysis

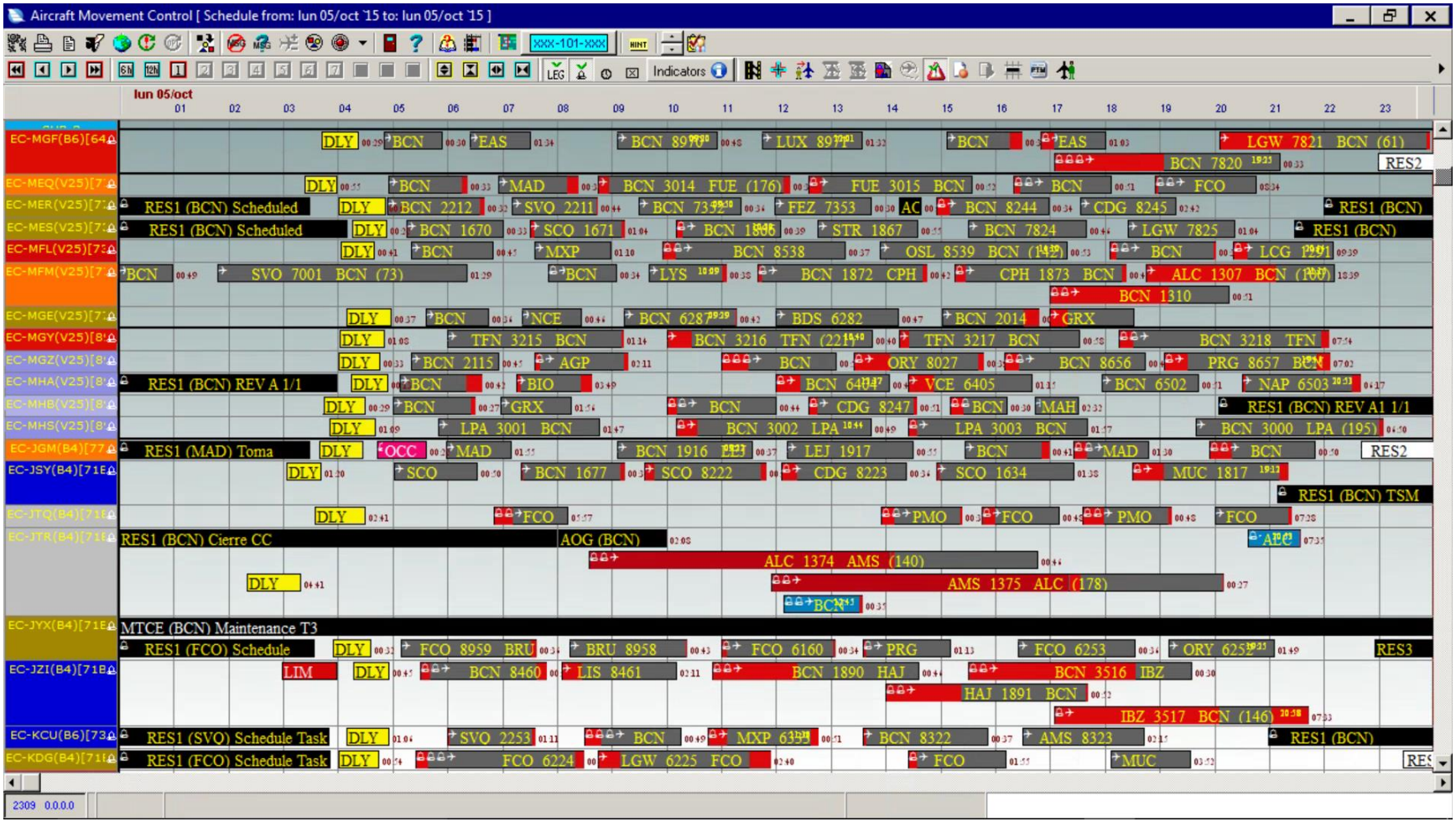
- Each plane is unique
  - Hard to train because of lack of data
- Heterogeneous information
  - Different sources
  - Different data types
    - Binary, numeric, photographs, video

DATA SOURCES

Systems diagram



Air Information Management System (I)



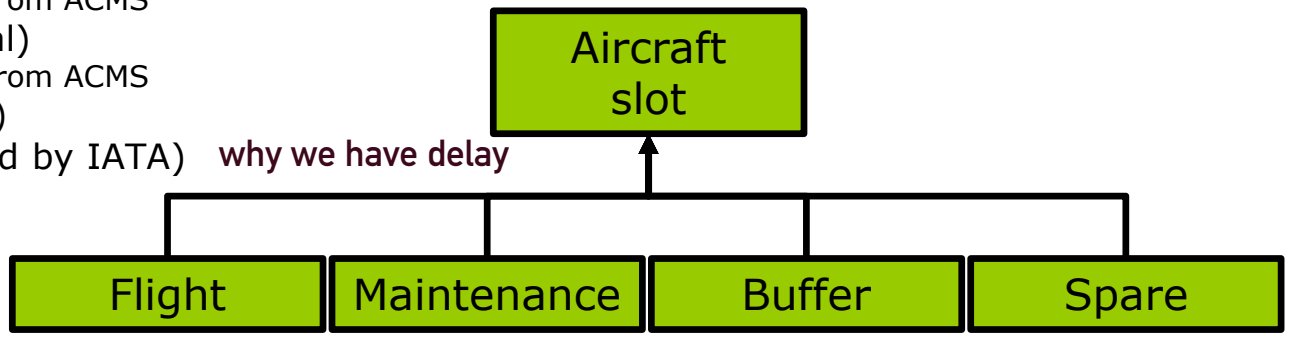
Air Information Management System (II)

- Aircraft slot
  - Aircraft Registration
  - Slot Start (Scheduled Time Departure)
  - Slot End (Scheduled Time Arrival)
- Flights
  - FlightID
    - Date-Origin-Destination-FlightNumber-AircraftRegistration
  - Arrival Airport
  - Departure Airport
  - Departure Time (actual)
    - Comes directly from ACMS
  - Arrival Time (actual)
    - Comes directly from ACMS
  - Cancelled(Boolean)
  - Delay code (defined by IATA)
  - Passengers
  - CabinCrew
  - FlightCrew
- Maintenance
  - Programmed (bool)
- Buffer (likely use)
- Spare/backup (unlikely use)

schedule time

**

If we have some delay(real time)



why we have delay

**

has these information

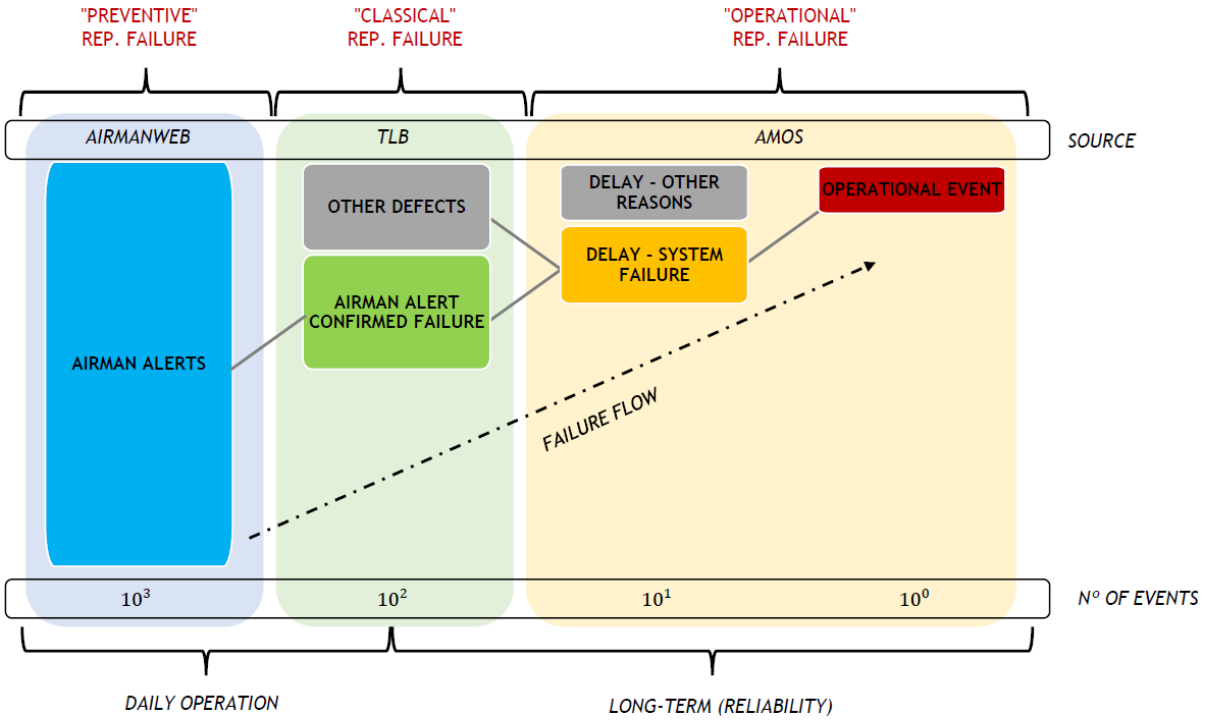
If maintance programed, but some of them are not

fouce on flight and maintenance

Buffer: jump to extra flight!

Maintenance flow

Sensors → Post Flight Report → Technical LogBook → Work Order



Sensors (provided by Teledyne)

- Aircraft Condition Monitoring System
  - Technology: Radio frequency (ACARS)
  - Number of sensors per plane: 400
  - Usage: Critical messages (e.g., touch-down)
  - Sampling Frequency: 1-3 times per flight
- DAR
  - Technology: 3G/SSD
  - Number of sensors per plane: 400 (same as above)
  - Usage: Non-critical messages (e.g., valve pressure)
  - Sampling Frequency: sub-second
- FOMAX
  - Technology: 4G
  - Number of sensors per plane: 24.000
  - Usage: Monitoring of aircraft subsystems
  - Sampling Frequency: sub-second
    - Size: 10GB per flight-hour

Post-Flight Report

- Sensor Events
  - Manufacturer Serial Number
  - Timestamp
  - Sensor
  - Value

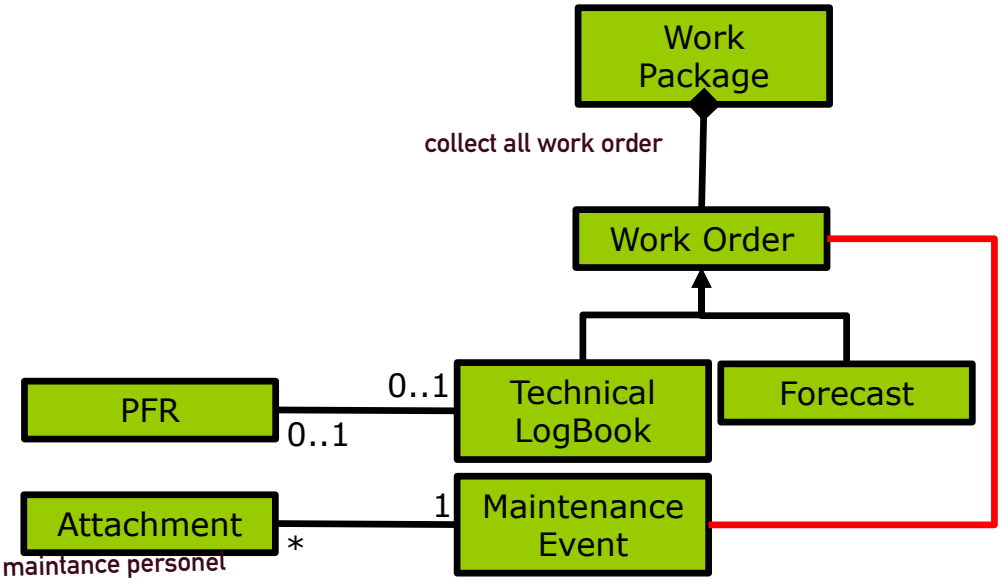
- Post-Flight Events
  - Aircraft Registration
  - Timestamp
  - Aircraft Subsystem ID (ATA code)
  - Kind of event (fault/warning)
  - Standard Message

Aircraft Maintenance Operation System (I)

- Work Orders
  - Work Order ID
  - Aircraft Registration
  - Execution date
  - Execution place
  - Subclasses (flagbased)
- Forecasted Orders (scheduled)
  - Deadline date
  - Planned date
  - Frequency (per #flights, per #days, #Miles)
  - AircraftSubsystemID (ATA)
  - ManHours forecasted
- TLB Orders (unscheduled)

(correspond to faults in PFR)

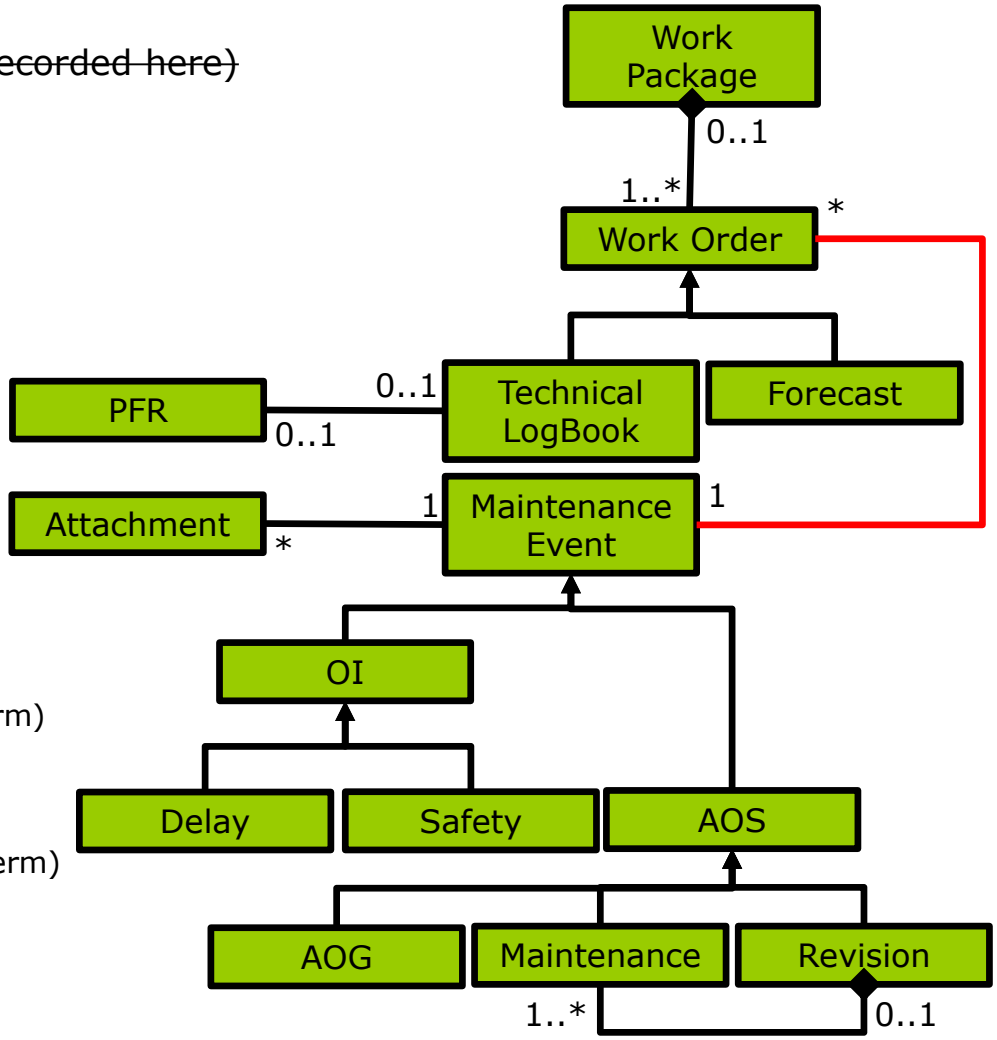
  - Due date
  - Deferred (Boolean)
    - MEL cathegory (3/10/30/120 days)
  - Registrar (PIREP/MAREP)
    - Personnel ID (Maintenance or Pilot)
- Maintenance Events
  - Maintenance Reference (ID)
  - Aircraft Registration
  - AirportID
  - AircraftSubsystemID (ATA)
  - Timestamp
  - Duration
  - Subclasses (flagbased)
    - Delays/Safety
      - FlightID
      - DepartureDate
      - DelayCode (IATA)
    - Aircraft On Ground (AOG)/Maintenance/Revision



Aircraft Maintenance Operation System (II)

- Operational interruptions (OI)
  - ~~Cancellation generating (not really recorded here)~~
  - Delay generating
    - Duration: Minutes (Very short term)
    - Scheduled: No
    - Frequency: 10.000/year
  - Safety concern generating

  (Return to Parking, Aborted Take Off, In Flight Turn Back, Flight Diverting)
    - Duration: Undetermined
    - Scheduled: No
    - Frequency: 365/year
- Aircraft Out of Service (AOS)
  - Aircraft On Ground (AOG)
    - Duration: Hours
    - Scheduled: No
    - Frequency: 2.400/year
  - Maintenance
    - Duration: Hours to one day (short term)
    - Scheduled: Yes
    - Frequency: 344/year
  - Revision
    - Duration: Days to one month (long term)
    - Scheduled: Yes
    - Frequency: 107/year



KEY PERFORMANCE INDICATORS

Aircraft utilization metrics

How aircraft is utilizing

- Flight Hours (FH)
  - Airborne time, i.e. wheels-off to wheels-on
- Flight Cycles (TO)
  - Number of Take off
- Aircraft Days Out-of-Service (ADOS)
  - Cumulated elapsed time (measured in days) that an operational aircraft was unavailable for aircraft operations due to the requirement to perform scheduled or unscheduled maintenance
    - Aircraft Days Out-of-Service Scheduled (ADOSS)
      - Cumulated elapsed time (measured in days) that an operational aircraft was unavailable for aircraft operations due to the requirement to perform scheduled maintenance
    - **Aircraft Days Out-of-Service Unscheduled (ADOSU)**
      - Cumulated elapsed time (measured in days) that an operational aircraft was unavailable for aircraft operations due to the requirement to perform unscheduled maintenance
- Aircraft Days In-Service (ADIS)
  - Cumulative elapsed time (measured in days, potentially with decimals) that an aircraft was used in aircraft operation (in-flight or ready for flight) and not undergoing maintenance (this is the complementary of ADOS)
- Daily Utilization (DU)
  - The ratio between the number of hours for a given period and the number of aircraft in-service for the same given period

    FH/ADIS
- Daily Cycles (DC)
  - The ratio between the number of take-offs for a given period and the number of aircraft in-service for the same given period

    TO/ADIS
- Delay Rate (DYR)
  - Delay Rate is the number of delays (between 15 minutes and 6 hours) incurred per 100 departures

    (DY/TO)*100
- Cancellation Rate (CNR)
  - Cancellation Rate is the number of cancellations incurred per 100 departures

    (CN/TO)*100
- **Technical Dispatch Reliability (TDR)**
  - Technical Dispatch Reliability is the percentage of departures that do not incur a delay or cancellation

    100 – ((DY + CN) / TO) x 100
- Average Delay Duration (ADD)
  - Average Delay Duration is the number of minutes in average for all delays incurred per 100 departures

    (Sum of delay duration > 15 minutes and < 6 hours / Nbr of delay duration> 15 minutes and < 6 hours) x 100

LogBook metrics

- Report Rate (RR)
  - General
    - Report Rate per hour (RRh)
      - Number of entries in the logbook per flight hour

        RRh = 1000 x (logbook count)/(total flight-hours)
    - Report Rate per cyple (RRc)
      - Number of entries in the logbook per take off

        RRc = 100 x (logbook count)/(total departures)
  - Depending on the role of the person reporting
    - PIREP Rate (PRR)

      PRRh =1000 x (Pilot logbook count)/(total flight-hours)

      PRRc = 100 x (Pilot logbook count)/(total departures)
    - MAREP Rate (MRR)

      MRRh =1000 x (Maintenance logbook count)/(total flight-hours)

      MRRc =100 x (Maintenance logbook count)/(total departures)

Airbus

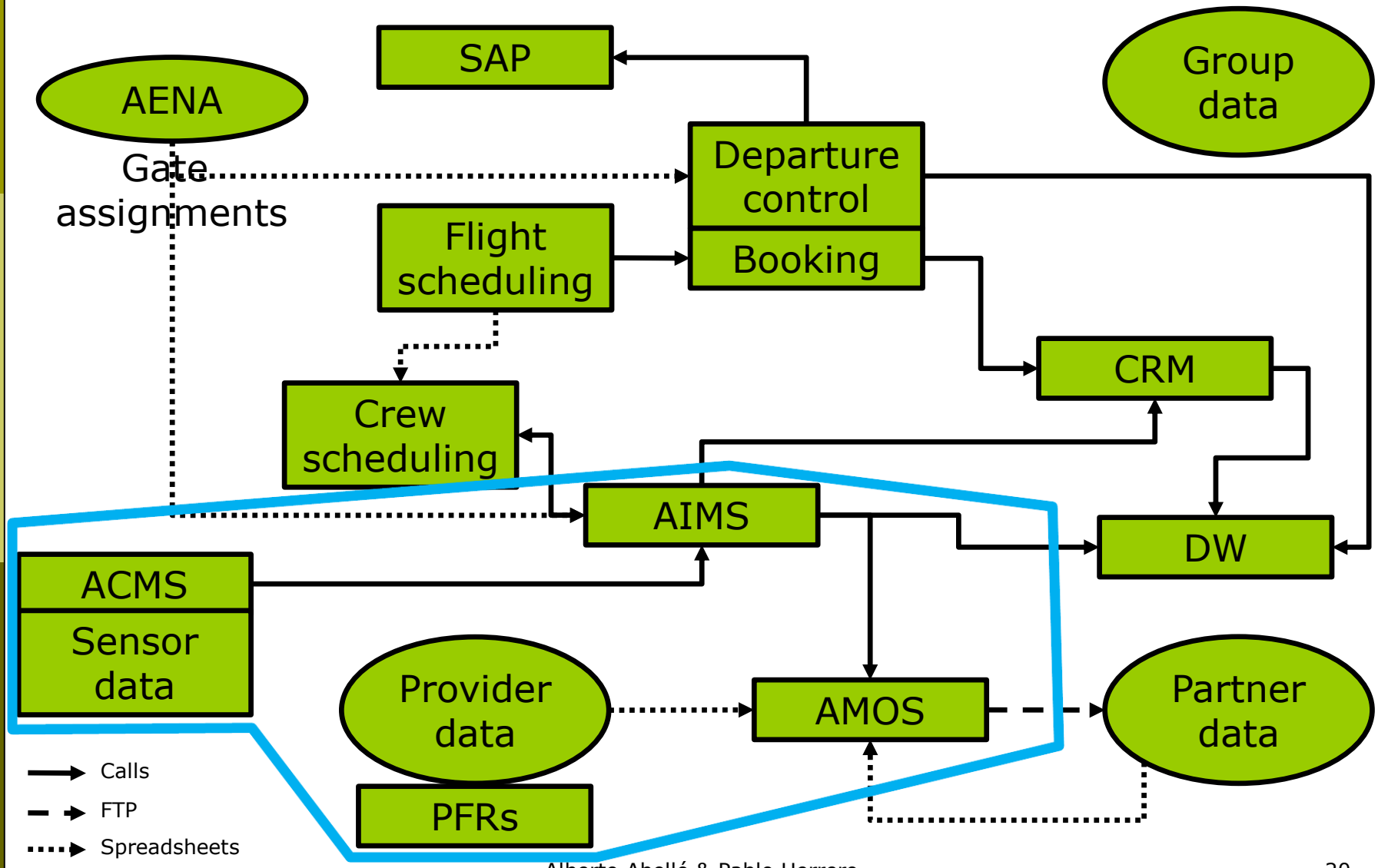
ANALYTICAL SOFTWARE

Skywise

"Extensible data pool that is harmonised to make it accessible to analytics which run across all of the inputs"

- Contains aircraft maintenance data
- SaaS
  - Multi-tenant
    - Web interface
- Features
  - Scalable
  - Standardized (allows comparison)
    - Ontological knowledge
    - Data governance
      - Regular daily extraction
  - Anonymized
  - Automatized

Relevant sources



Data flows frequency

Frequency \ Data Source		Airbus	Field Rep			Field Rep (if any) or Airline	Airline					CSD
		Email	Technical Message via Tech Request and validation in e-collection	E-collection (Field reps)	FSM template	ETOPS template	Spec 2000	DFT template	Misc. Files	Excel file	Airline DMC toolset	CDB template
A/C Reliability	Events (Operational interruptions & Tech. Incidents)		D	D			D	D				
	Flight hours and Take-offs per MSN (Tot and Rev)			M			M	M		M		
	Technical logbook			W			W			W		
	Aircraft days Out of service			M			M	M		M		
	Engine/APU removals details (Level 2)			W			W			W		
Components reliabilit	LRU removable details (Level 2)						W			W		
	Components shop findings (Level 2)						W			W		
ETOPS	ETOPS Flight hours and Take-offs per MSN			M			M	M		M		
	Routes					Y						
	Operator approval					Y						
	Milestosnes and Certifications	OR										
Direct Maint	DMC Airline										Y	
Fleet Mngt	Transfer of A/C								OR			OR
	Change of A/C status								OR			OR
FSM monthly report	General information (Training, Operations, Engineering, Maintenance, Fuel, Services, OEB status…)				M+20							

Data loading means

- Full Automatic Data Transfer
- Data Loading Interface
  - SPEC2000 files upload
  - Direct Excel extracts upload
  - Data File Transfer Template
- Manual Input by Airbus Field Service

Subsystems

- **Hubble**
  - Purpose: Search data
  - User type: - (new comer)
- **Monocle**
  - Purpose: Visualize and manage data flows (including code of transformation)
  - User type: Developer
- **Countour**
  - Purpose: Exploratory analysis of data (descriptive analytics)
  - User type: Domain expert
- **Report (static view of Contour)**
  - Purpose: Publishing descriptive analysis
  - User type: Manager
- **Slate**
  - Purpose: OLAP-like dashboard analysis
  - User type: Executive (decisor)
- **Quiver**
  - Purpose: Analyse flight sensors (for predictive analytics)
  - User type: - (not in use)
- **Other**

Alternative to Engine Health Monitoring

- Contains engines' data
- Features
  - Pre-defined blackbox indicators