
ACME-Flying Use Case

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- ❑ Analytical software

DOMAIN CHARACTERISTICS

Company characteristics

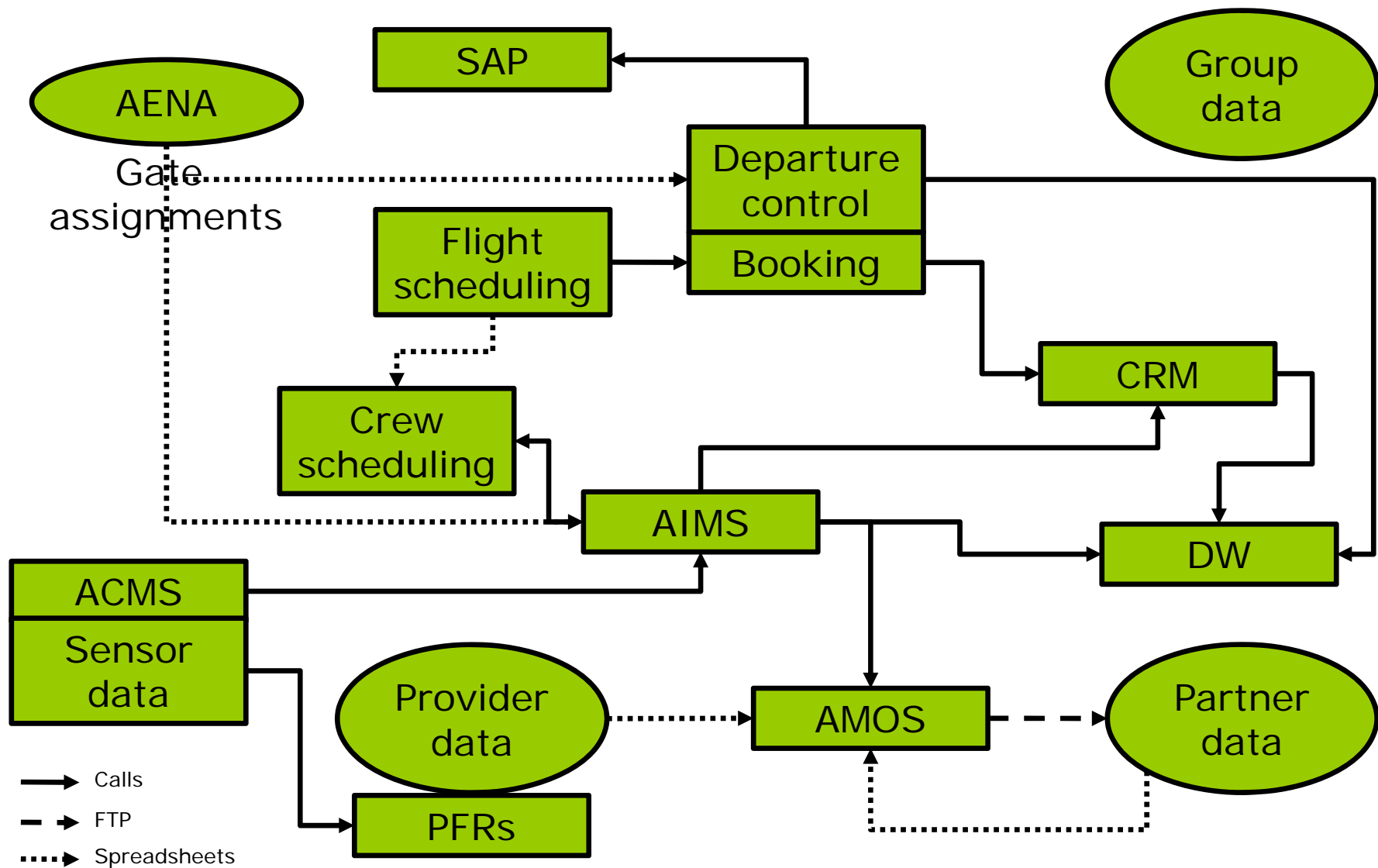
- ❑ Planes: 125
- ❑ Destinations: 120
- ❑ Flights:
 - Per day: ~700
 - Per year: ~300.000
- ❑ Post-Flight Report events
 - Per year: ~1.000.000
- ❑ Maintenance events:
 - Per year: ~13.000
 - ❑ ~10.000 Delays (non-programmed short)
 - ❑ ~2.400 Aircraft On Ground (non-programmed long)
 - ❑ ~350 Maintenance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

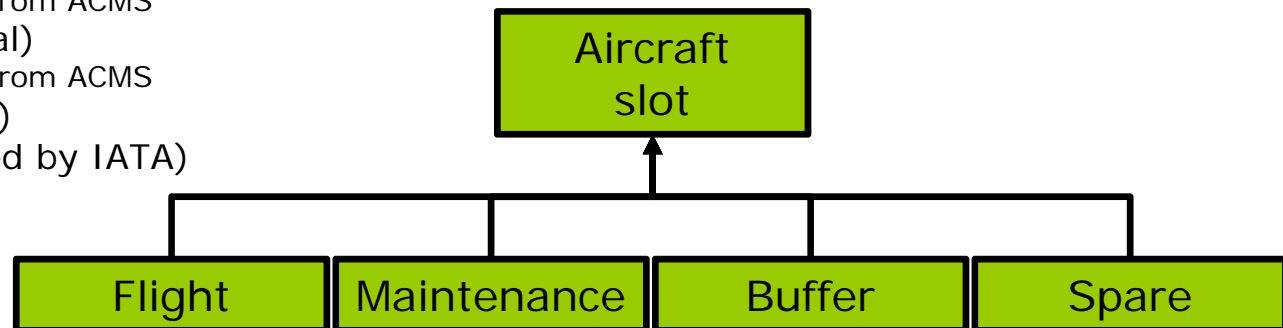
DATA SOURCES

Systems diagram

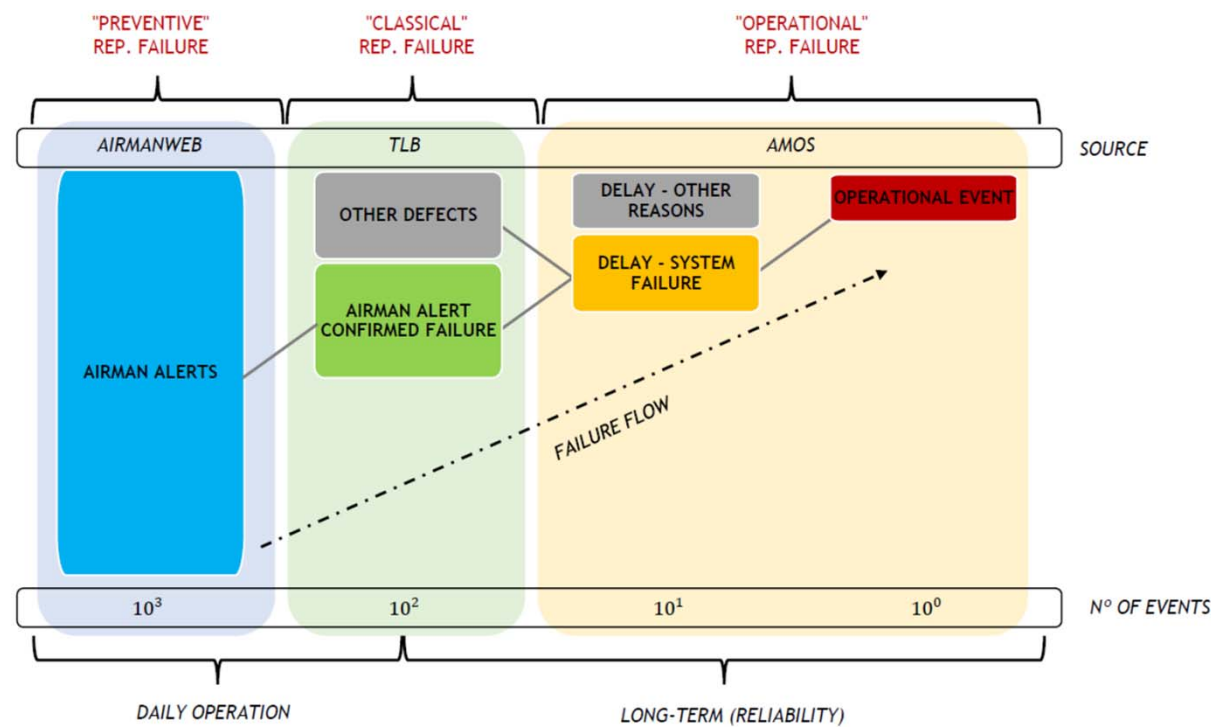


Air Information Management System

- 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)



Maintenance flow



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

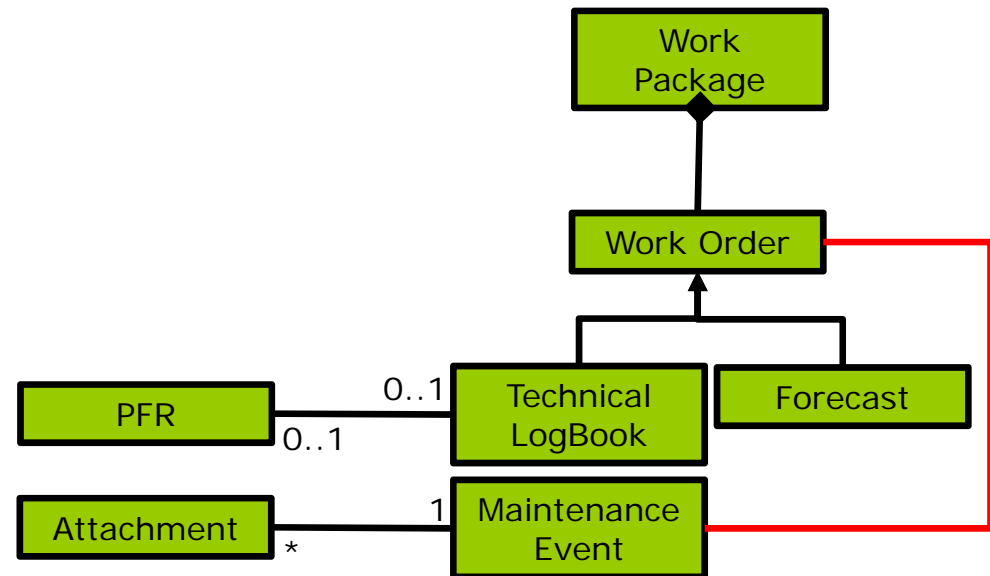


□ Post-Flight Events

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

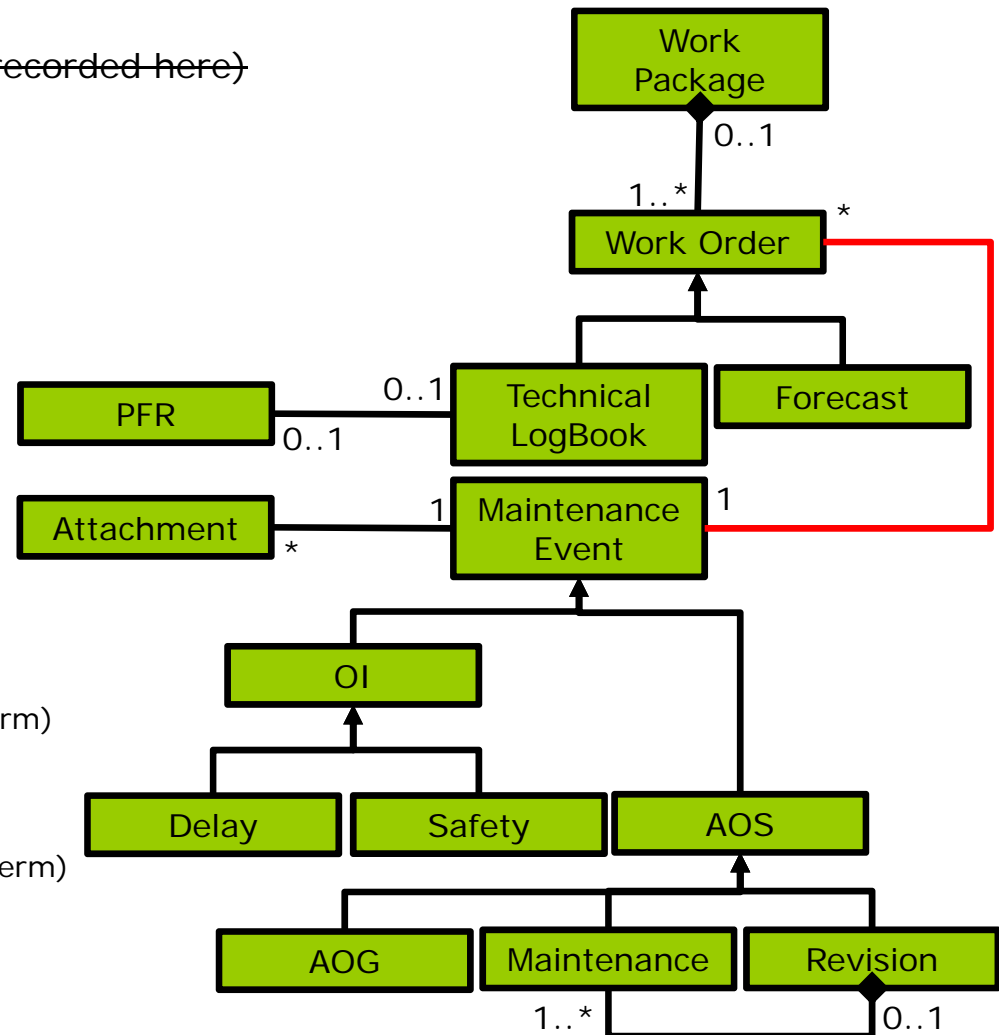
Aircraft Maintenance Operation System (I)

- 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 category (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

- Flight Hours (FH)
 - Airborne time, i.e. wheels-off to wheels-on
- Flight Cycles (TO)
 - Number of Take off
- Aircraft Days In-Service (ADIS)
 - Cumulative number of elapsed days (decimal) that an aircraft was used in aircraft operation (in-flight or ready for flight) and not undergoing maintenance, not parked and not stored
- Aircraft Days Out-of-Service (ADOS)
 - Cumulated number of elapsed days (decimal) that the operational aircrafts of a given type were unavailable for aircraft operations due to the requirement to perform scheduled or unscheduled
 - Aircraft Days Out-of-Service Scheduled (ADOSS)
 - Cumulated number of elapsed days (decimal) 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 number of elapsed days (decimal) that an operational aircraft was unavailable for aircraft operations due to the requirement to perform unscheduled maintenance
- 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

$$\text{FH/ADIS}$$
- 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

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

$$(\text{DY/TO}) \times 100$$
- Cancellation Rate (CNR)
 - Cancellation Rate is the number of cancellations incurred per 100 departures

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

$$100 - ((\text{DY} + \text{CN}) / \text{TO}) \times 100$$
- Average Delay Duration (ADD)
 - Average Delay Duration is the number of minutes in average for all delays incurred per 100 departures

$$(\text{Sum of delay duration} > 15 \text{ minutes and} < 6 \text{ hours} / \text{Nbr of delay duration} > 15 \text{ minutes and} < 6 \text{ hours}) \times 100$$

LogBook metrics

□ Report Rate (RR)

■ General

□ Report Rate per hour (RRh)

- Number of entries in the logbook per flight hour

$$RRh = 1000 \times (\text{logbook count}) / (\text{total flight-hours})$$

□ Report Rate per cycle (RRc)

- Number of entries in the logbook per take off

$$RRc = 100 \times (\text{logbook count}) / (\text{total departures})$$

■ Depending on the role of the person reporting

□ PIREP Rate (PRR)

$$PRRh = 1000 \times (\text{Pilot logbook count}) / (\text{total flight-hours})$$

$$PRRc = 100 \times (\text{Pilot logbook count}) / (\text{total departures})$$

□ MAREP Rate (MRR)

$$MRRh = 1000 \times (\text{Maintenance logbook count}) / (\text{total flight-hours})$$

$$MRRc = 100 \times (\text{Maintenance logbook count}) / (\text{total departures})$$

Airbus

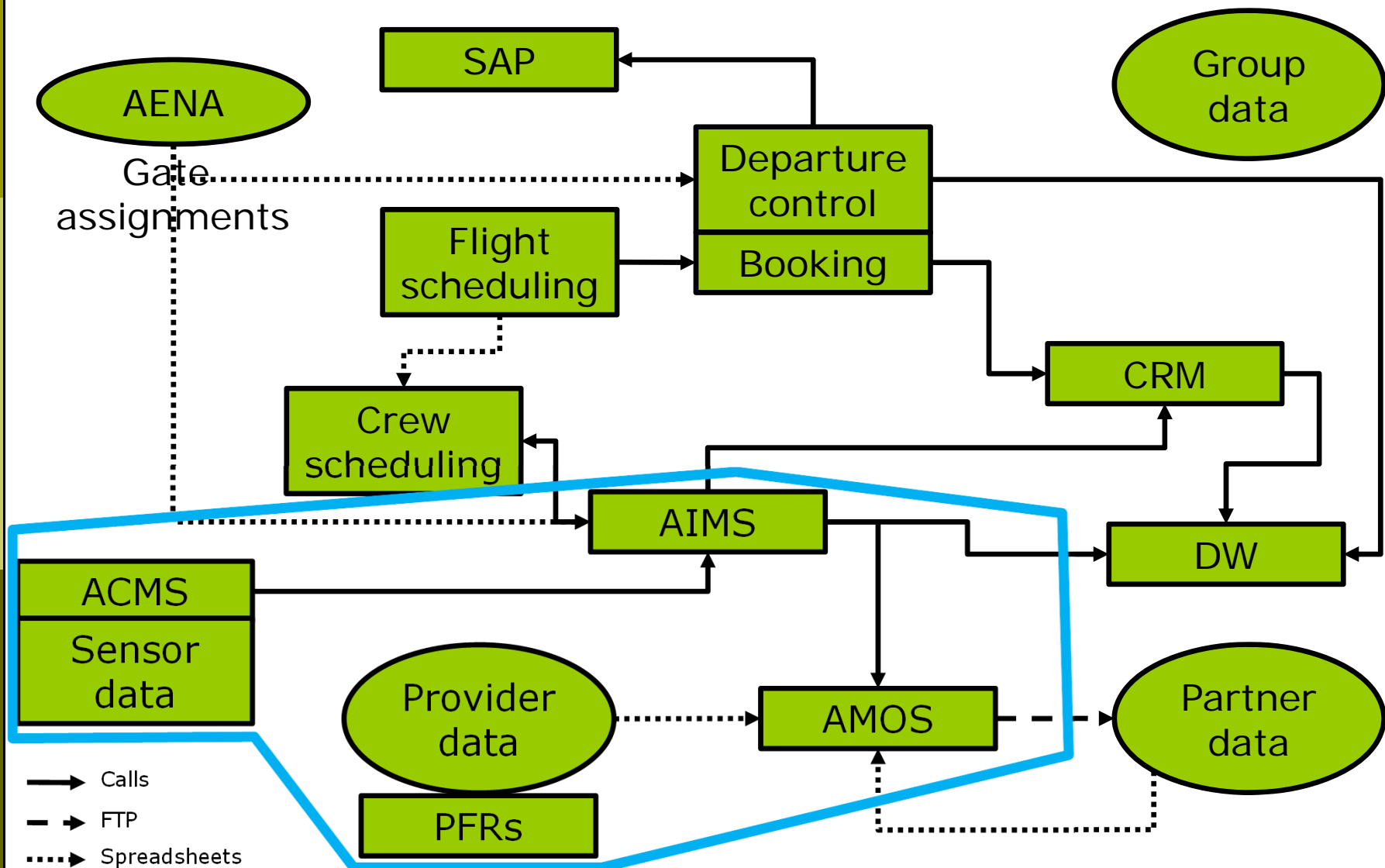
ANALYTICAL SOFTWARE

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

Data Source Frequency		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 reliability	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						
	Milestones and Certifications	OR										
Direct Maintenance	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