



UAM Fleet Manager Gap Analysis

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Dispatchers for UAM



- How do the functions of a UAM dispatcher (“Fleet Manager” or FM) compare with the airline dispatcher (AD)?
- Listed tasks for AD and FM and identified differences
- Created a list of software functions and information requirements for the FM
- Started a user interface (UI) design for an FM software tool

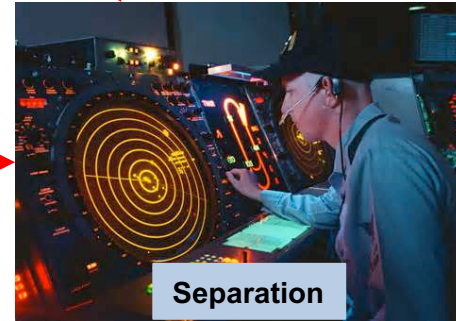
Who is the Airline Dispatcher?



Flight Planning & Monitoring



Piloting



Separation



What Do Airline Dispatchers Do?



- ADs are airline employees who manage all flights
- Dispatchers have the authority to originate and terminate flights
- Generate flight plans and monitor flights throughout their routes
- Manage contingencies (weather, air traffic control, and maintenance)
- ADs work in an airline operations center (AOC)
- AOCs also provide other functions, such as crew scheduling and maintenance management

Airline Operations Center



Southwest Airlines Network Operations Control



Airline Dispatcher Tasks



- ADs are licensed airman certified by the FAA
- Have joint responsibility with the captain for operational control of a flight
- Manage safety, economics, fuel planning, passenger service, and support the brand of the airline
- Closely analyze and evaluate meteorological information to determine potential hazards to the safety of flight
- Deeply versed in federal regulations for aviation
- The AD makes recommendations to continue to destination, or to divert if needed

Flight Planning



- Software automatically generates fuel/time efficient flight plan
- Contents of flight plan:
 - Weight and balance of the aircraft
 - Fuel load
 - Alternate airports
 - Load manifest
 - Passenger load/count
 - Weather
 - Filed route
 - Maintenance items

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FLIGHT 3407                COMPUTER FLIGHT PLAN                TODAY
-----
ORG  DEST  ALT1  ALT2  T/OALT  A/C TYPE      TAIL   BOW      INDEX
PHL  DCA                    EMB-170NXXXXX  48300  -02.15

SPEED SCHEDULES
CLIMB 290/M74                CRUISE M78                DESCENT M74/290

      FUEL   TIME      PLAN          STRUC      FLT SKD
BURN   1739  00.26  BOW  48300.....  DEP PHL NOW  Z
RESERVE 3200  00.45  PYLD 6599.....  ARV DCA LATER Z
ALT/    0    00.00  ZFW 54899.....  65256
HOLD    0    00.00  FOB 6400.....  20734
MIN    4939  01.13  TOW 61299.....  81964
TANKER 1461  00.21  BURN 1739
TAXI   400  00.20  LGW 59560.....  72310
RAMP   6800  01.34  FOD 4661

ROUTE 001  P NOW Z  FL 120  AVG WIND 016004      ETE 00.26
PHL..DQO.V166.BELAY.V378.BAL..DCA
+
CONTINGENCY SUMMARIES
FL  AVG/WIND  ETE  BURN  MIN  RAMP  PYLD  LDG WT
80  049005  00.26  1772  4972  6800  6599  59527
60  065006  00.26  1808  5008  6800  6599  59491
40  072006  00.26  1853  5053  6800  6599  59446

      TIME  DIST
      LEG  LEG  IAS  MCH  MC  ALT  WIND  FUEL
WAYPOINT TOTAL TOTAL TAS  G/S HDG IOAT ISA  LEG  SCORE
KPHL      ----  ----  ---  ---  ---  ---  ---  ---  ---
      00.26  109  ---  ---  ---  ---

TOC      00.02  11  232  ---  ---  120  043005  360  ..../....
      00.02  11  273  278  248  8  P10  360
    
```

Flight Release



- An AD prepares a Dispatch Release for each respective flight
- Dispatch Release (or Flight Release) is a legal document
- The AD and pilot in command formally agree to the operational control of the flight by signing the Dispatch Release

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NAS:
FP SWA40 B733/Q 426 DAL P2220 370
DAL.TEX1.MLC..SGF.TRAKE8.STL/0129 EQP DGILORVWZ SRV S NAV/ RNVD1E1A1

MEL/CDL      NO ITEMS

                Fuel   Time   Plan                Structural
                                Plan                Limit

TAXI           0005
ENROUTE BURN   0077   01:29  OEW   074446
CONTINGENCY    0026   00:30  PLYD  030500
ALTERNATE      0000   00:00  ZFW   104900  MZFW 1050
FAR RESERVE    0035   00:45  FOB   013800  MFW  0356
*****
MINIMUM FUEL   0143   02:44  TOW   118700  MTOW 1360
*****
TANKER         0000   00:00  BURN  007700
PLAN FOB       0143   02:44  LGW   111100  MLGW 1140

PLANNED ARRIVAL FUEL 0061      ESTIMATED MAX QUICK TURN WGT 1199

AVG WIND MO31   MXSH 05/SGF      FUEL BIAS + 3.9%   CRZ C20/W
NFUEL BURN ADJUSTMENT FOR 1000LBS DECREASE IN TOW : 0054 LBS
    
```


Dispatcher Workstation



- Left Screen: Fleet management
- Middle Screen: Flight Planning, general information, and Aircraft Communications Addressing and Reporting System (ACARS) messaging
- Right Screen: Weather, flight tracking
- Phone/air-ground radio contact other personnel and aircraft in flight
- About 20 to 40 flights per dispatcher at any given time – follow tail numbers



Maintenance



- Uses Minimum Equipment List (MEL) for each type of aircraft in the fleet
- Checks errors/faults to determine if aircraft can fly
- Receives messages from dispatch and pilots about MEL items
- Has a direct voice line to the flight deck if troubleshooting is needed
- Responsible for scheduling maintenance at the airport

U.S. DEPARTMENT OF TRANSPORTATION		MASTER MINIMUM EQUIPMENT LIST	
FEDERAL AVIATION ADMINISTRATION		REVISION NO: 20	PAGE:
AIRCRAFT: BOEING B-777		DATE: 04/14/2014	21-9
SYSTEM & SEQUENCE NUMBERS	ITEM	1.	2. NUMBER INSTALLED
21 AIR CONDITIONING			
-27-16	Flight Deck Equipment Cooling System (777F)	C	1
			0
		3. NUMBER REQUIRED FOR DISPATCH	
		4. REMARKS OR EXCEPTIONS	
		(M)(O) May be inoperative provided: a) Equipment cooling three-way valve is deactivated closed, and b) Procedures are established and used to verify main deck cargo compartment remains empty or contains only ballast, empty cargo handling equipment (ballast may be loaded in ULDs), or fly away kits.	
		NOTE: Operator MELs must define which items are approved for inclusion in the fly away kits and which materials can be used as ballast.	

UAM and the Dispatcher



- For UAM, a human dispatcher will be necessary during operations (initially)
- Duties include flight planning, flight following, contingency management (e.g., weather, maintenance, and air traffic control)
- There are differences between UAM and airline operations, but there are many similar tasks

Domains Compared



Present Day Aviation	Urban Air Mobility
Large aircraft (B777 is 774,600 pounds)	Small aircraft (2,000 - 4,000 pounds)
Many passengers (hundreds)	Two to four passengers
Highly structured airspace	Less structured airspace
Local and high-altitude weather data	Detailed weather data for low altitudes
Voice radio communications	Digital data and voice communications
Operations segregated from public	Operations integrated with public
Robust performance in weather	Highly susceptible to weather
NAS-wide air traffic control (ATC) services	Operator-provided ATC services
Scheduled operations	Unscheduled operations
Avoids urban areas	Operates in urban areas
Sophisticated airports	Simple landing pads or “land anywhere”
Highly trained flight crews	Minimal flight crew training
Partial reliance on automation	Heavy reliance on automation
Complex maintenance requirements	Simple maintenance requirements

Comparison of Tasks



2. Gap Analysis

In Table 2, current airline dispatcher tasks are listed with the comparable FM task. Tasks in bold have significant differences compared to conventional dispatcher tasks.

Airline Dispatcher Task	Fleet Manager Task
Dispatcher arrives for their shift and is briefed by the outgoing dispatcher.	The outgoing FM uses their software to note and communicate issues to the incoming FM. The FM's workstation should have a software tool that summarizes all of the important information to be passed on to the relief FM. The next shift may be manned at a different office in another part of the country.
Electronically logs into the dispatcher workstation.	The FM logs into their workstation.
Launches flight planning system.	FM plans the flight with different information compared to that used for large aircraft. The UAM route structure will most likely use lat/longs for waypoints, pre-defined routes, corridors, etc.
Launches aircraft situational display (ASD) system.	FM launches their ASD. The ASD is a primary tool for the FM. However, due to the shorter range of an air taxi, the ASD must be refined to have the ability to view geographical and weather data on a micro scale, using new sensor suites.
Launches communication console.	FM launches the UAM communications console (e.g. radio, cell phone, text messaging, etc.).
Identifies any electronic messages that were not observed during the turnover process.	FM uses their communications console to identify any new messages.

Main Findings (Gaps)



- FM needs software tool for shift change (different locations)
- Flight planning will have different parameters (lat/longs for waypoints, pre-defined routes, corridors, etc.)
- FM's situation display must present very detailed geographical and weather information
- Weather data are focused on low altitude operations
- FM manages low altitude traffic over urban areas
- FM will need to handle on-demand flights
- Payload and weight balance will be critical for small aircraft

Main Findings (Gaps)



- Standard (recurring) routes will need to be checked due to constantly changing low altitude environment
- Altitude selection for flights may be very limited
- Flight plan may be an “Operation Plan,” similar to UTM
- Submits Operation Plan to a service supplier rather than the FAA
- FM does not coordinate with the FAA but with corporate service provider traffic management

Software Functions: Operations



- Flight planning
- Flight following
- Flight path manipulator (in the event of a contingency)
- Conflict prediction and status
- Alternate route suggestions
- Airspace corridor saturation monitor
- Weather integration into decision-making
- Aircraft energy/consumption monitor
- In flight route optimizations

Software Functions: Communications



- Voice and text links with pilot
- Messaging with passengers
- Voice and data communications with air traffic management/local authorities
- Data communications with service suppliers
- Two-way data contact with aircraft (equipment status, fuel/battery level, etc.)
- Voice and text with vertiports
- Voice and text with maintainers

Software Functions: System



- Replacement vehicle availability
- Live repair turnaround estimates
- Role management and delegation
- Alarms or warnings of upcoming system downtime and faults
- Backup pilot for emergency events

Data Requirements: Map



- Aircraft position, identifier, speed, heading, altitude, and flight plan
- Flight corridors
- Speed and descent profiles
- Trip length
- Human-made and natural obstructions (e.g., buildings, trees, hills, etc.)
- Temporary Flight Restrictions
- Special Use Airspace
- Landing area issues
- Noise regulations that affect vehicle choices
- Other aircraft position, identifier, speed, heading, altitude, and flight plan
- Reception obstruction areas
- Vertipad/vertiport detailed map view with traffic
- Vertipad/vertiport status
- Emergency and safety related notices affecting flights

Data Requirements: Weather



- Very detailed weather information for the altitudes and areas of concern
- Very rapid surface to 5000 feet weather changes
- Micro-scale weather detection and prediction
 - Barometric pressure
 - Temperature
 - Relative humidity
 - Dew point
 - Wind speed and direction
 - Icing
- Detailed wind flows for urban canyons, structures, topographical areas, vegetation (e.g., forests, valleys, bridges, etc.) with a few meter resolution
- Ice formation on the ground
- Localized ceiling and fog

Data Requirements: Aircraft



- Aircraft type
- Fuel/battery capacity, range, and remaining
- Time to charge battery
- Payload:
 - Aircraft capacity
 - Weight
 - Manifest
 - Loading notes
- Routing
- Human pilot or ground pilot
- Safety procedures
- Deferred maintenance items
- Repair and maintenance data
- Onboard system status

Data Requirements: Communications



- Downloads of updated regulations, management advisories, etc.
- Information about crew schedule changes
- Security or emergency items (terrorism threats, reroutes, medical emergencies)

Data Requirements: System



- Company system status (communications, facilities, personnel, etc.)
- Gate assignments
- Crew changes
- Curfew issues
- Noise footprint
- Noise abatement
- Backup pilot for emergency events

Software Design Philosophy



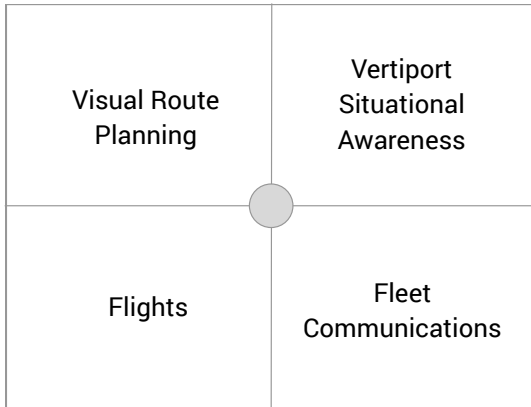
- FMs may be challenged by the number of flights they must handle
- Complex, low-altitude vehicle management
- Information displays should be forward-looking and provide decision support
- UI architecture provides two modes:
 - Recommended actions based on user tasks
 - Background data behind decisions, if requested
- System capabilities include:
 - Optimize FM to vehicle management ratio
 - Predictive interactions as a core design principle
 - Decrease training needs of FMs vs. ADs
 - Enhance safety of low altitude, automated flight conditions

UI Design

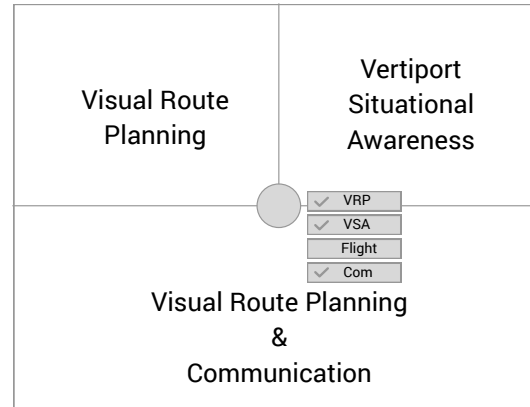


- FM UI uses a single, large, windowed display
- Information in the interface is integrated:
 - User chooses a route
 - Software creates the route
 - Map graphically shows a problem with the route
 - Computer generates suggested solution
 - User communicates the chosen action to others, logs the issue, and monitors the flight path
- Software supports prediction, monitoring, and execution

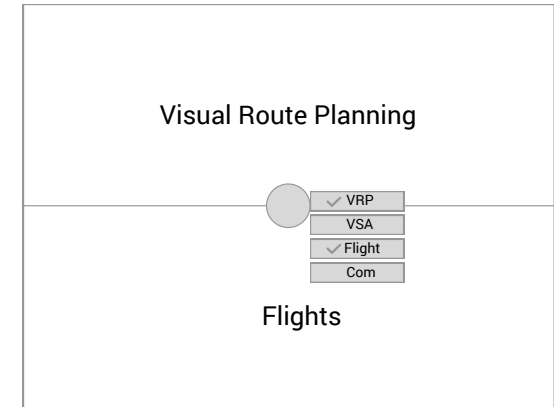
Interface layout 1



Interface layout 2



Interface layout 3



The maximum number of windows is four. The user can drag and drop the controller at center (indicated by a gray circle) to resize all windows simultaneously.

Starting with the top left quadrant and going clockwise:

- Visual Route Planning for assisted optimization
- Vertiport Situational Awareness for monitoring
- Flight monitoring
- Fleet Communications

To change the number of windows, right-click on the controller (indicated by a gray circle). A menu appears allowing users to toggle on/off each of the four windows. Toggling off a window results in a three window view as in the example above.

Toggling two windows off results in a split view as shown in the example above. Users may toggle on/off windows as necessary.



J. Bridenstine
Admin

- Preferences
- Show Layers
- Assisted Automation**



Look-Ahead Notifications

- 12:42PM Potential pad failure [VIEW](#)
- 01:00PM Heavy wind assist [VIEW](#)

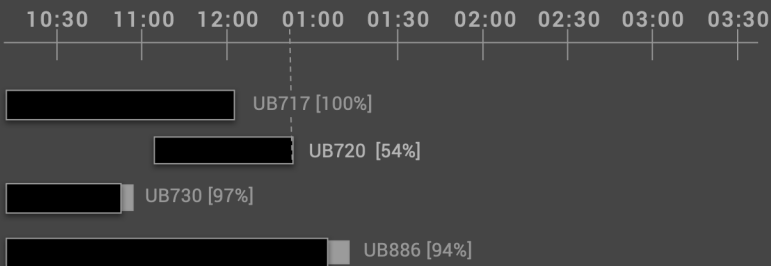
San Francisco

UB720
Arr: 12:10:13PST
Efficiency: 54%
Optimization in progress...

UB730
UB717
UB886
UB720 200 80

UB720 Optimization Profile

FLIGHT#	SEGMENT DISTANCE	TIME AT SEGMENT
UB717	11.2 miles	12:12PM 100% optimized
UB720	11.1 miles	12:12PM 54% calculating options



ACCEPT MODIFY

ISSUES

CHAT

NOTES

Potential pad failure at SFO, to be advised as situation progresses [Pad](#)

Weather cell forming in the Pacific

Police line at 19th and Wawona

Heavy winds reported via microweather sensor [4th Street] [Wind](#)

Passenger requests additional stop at Embarcadero Center

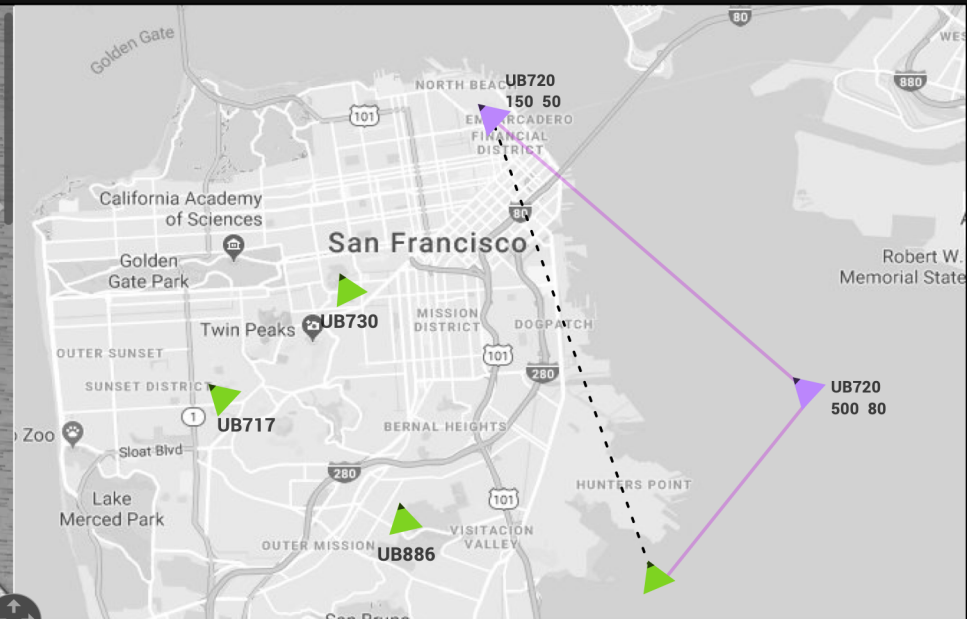
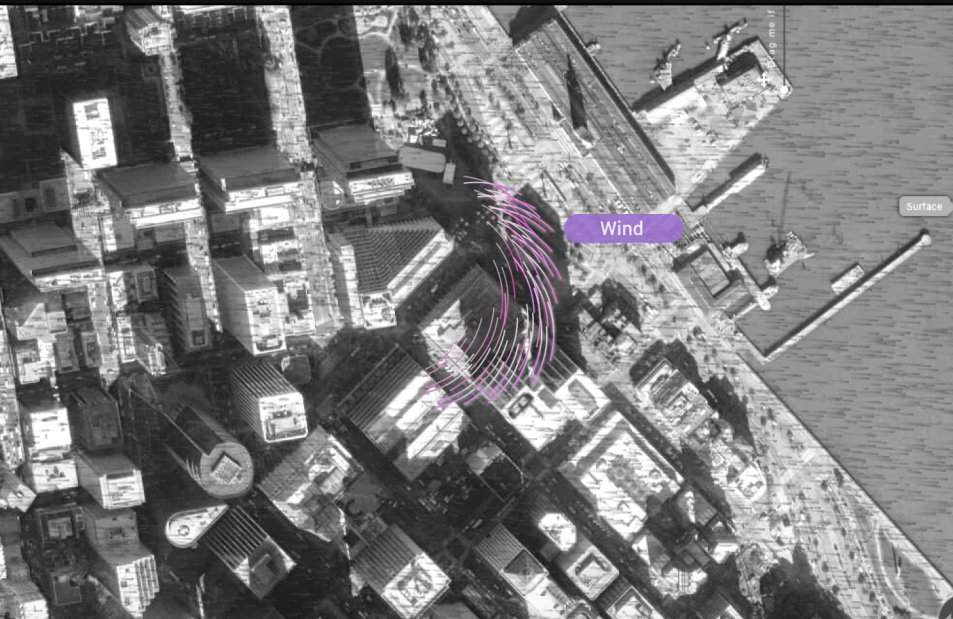
Dispatch calls in a delay due to late passenger arrival

Traffic backing up highway 101 at Monterey Blvd

Evening operations shift change

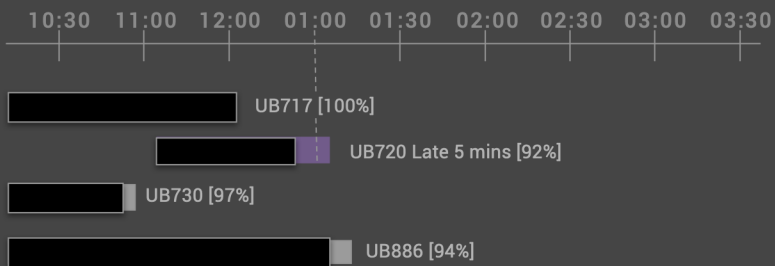
Route change due to passenger sickness

Passenger left Ham radio in air taxi



UB720 Optimization Profile

FLIGHT#	SEGMENT DISTANCE	TIME AT SEGMENT
UB717	11.2 miles	12:12PM 100% optimized
UB720	12.6 miles	12:17PM 92% optimization available



ACCEPT MODIFY

ISSUES

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Pad

Weather cell forming in the Pacific

Police line at 19th and Wawona

Potential re-route due to heavy winds

Wind

Passenger requests additional stop at Embarcadero Center

Dispatch calls in a delay due to late passenger arrival

Traffic backing up highway 101 at Monterey Blvd

Evening operations shift change

Route change due to passenger sickness

Passenger left Ham radio in air taxi

Next Steps



- Additional UI design
- Sent Gap Analysis to Uber
- May be interested in collaboration later in the year



Questions?