Understanding Role of Flight Data Processing Across NAS Operational Domains

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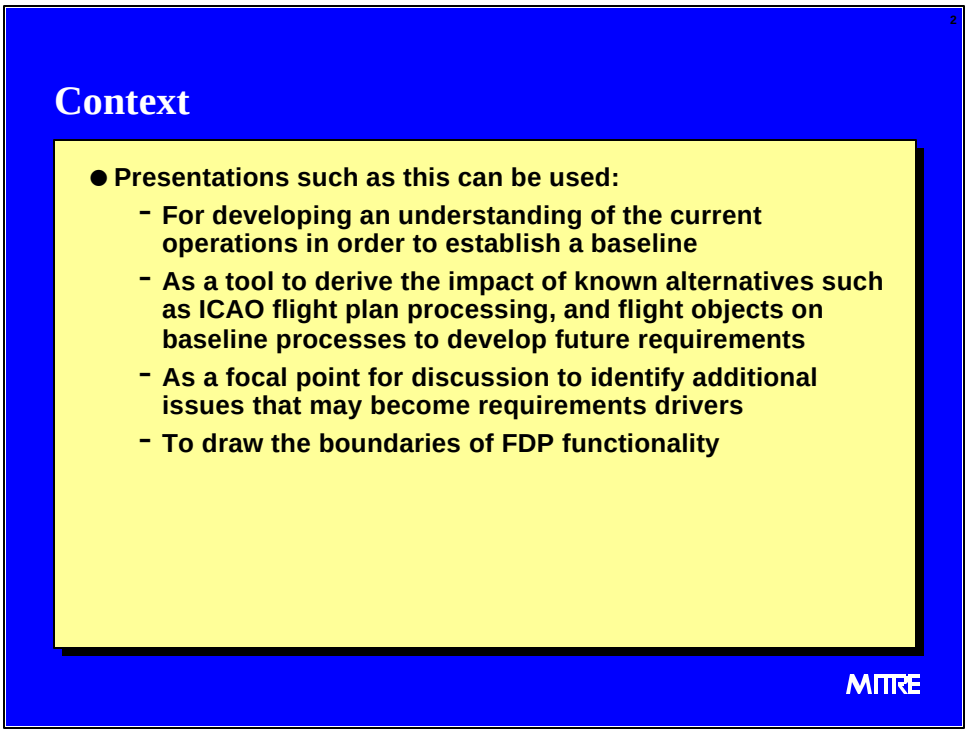

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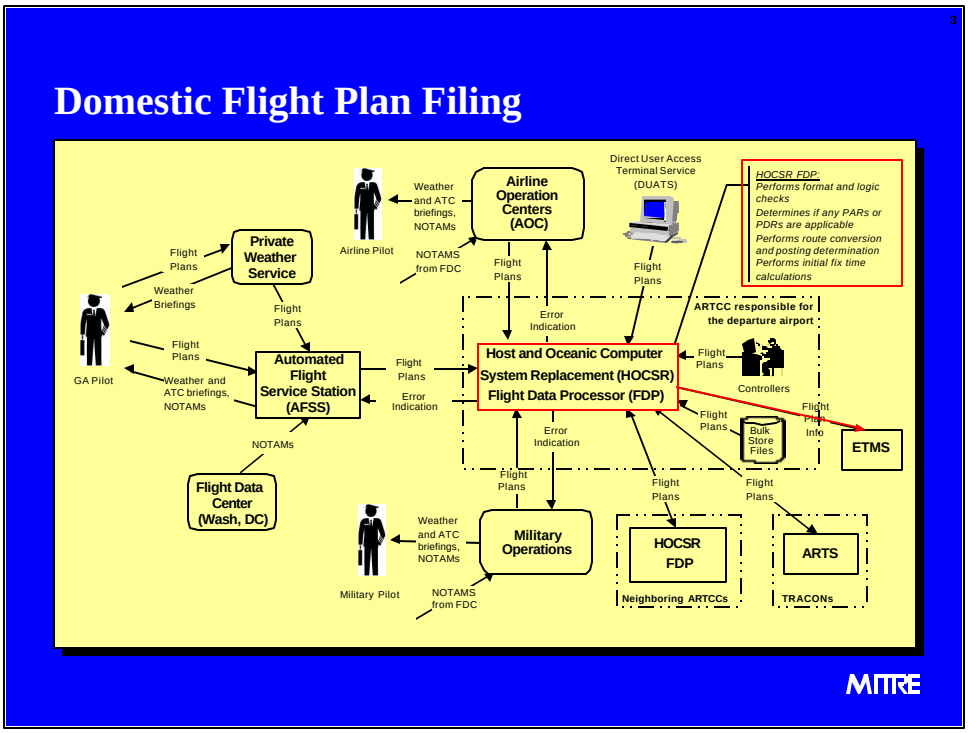

Filing the Flight Plan Pilots of personal and corporate aircraft usually contact a flight service station (FSS) to file a flight plan and receive weather briefings. An increasing number of these pilots use private weather-briefing firms and are able to file flight plans directly through these organizations. Airline pilots usually have their flight plans filed for them by the airline itself. Military pilots usually file flight plans through their military operations office.

After contacting the flight service station, the pilot receives a thorough weather briefing that includes both current and forecast weather along the route of flight and learns of any adverse conditions affecting the ATC system or the destination airport that may influence the pilot's decision. These conditions include known or suspected ATC delays, navigation equipment outages, and any notices to airmen (NOTAMs). NOTAMs are entered into the FAA computer system by local flight service stations or at the Flight Data Center (FDC) in Washington, DC. NOTAMs issued by local flight service stations concern local conditions such as airport or runway closures and unlit obstructions. NOTAMs issued by the Flight Data Center, known as FDC NOTAMs, concern en route navaid outages, changes to published instrument approach procedures, or any emergencies.

Flight Plan Entry

Flight Service Station Once the weather briefing is completed, the flight service specialist obtains the proper flight plan information from the pilot and enters it into the FSS computer. Within a short time, the appropriate information is sent to the flight data processing computer at the ARTCC with responsibility for the departure airport. The HOCSR FDP computer checks the validity of this information and, if it is correct stores it for later use.

If the route information entered by the specialist at the FSS is incorrect or incomplete, an error message is returned to the FSS. It then becomes the specialist's responsibility to correct the entry, ensuring that the route information is complete. At this point the abbreviation FRC (Full Route Clearance) is appended to the corrected flight data and then retransmitted to the ARTCC. The abbreviation FRC is then printed on the aircraft's flight progress strip, which alerts subsequent controllers that changes were made to the pilot's route of flight.

The information received at the ARTCC is handled by Flight Services Data Processing System (FSDPS), which communicates with the HOCSR FDP via NADIN 1A Service B interface. The HOCSR FDP checks the route and determines whether any preferred departure routes (PDRs), preferred arrival routes (PARs), or preferred IFR routes apply to that particular aircraft. PDRs and PARs are determined by a letter of agreement or through facility directives. If this particular flight will be affected one of these types of routes, the preferred route will be printed on the flight progress strip bracketed by plus signs.

Airline Operations Airlines file their flight plans either using the bulk store facility, or in the FSDPS. Some airlines use DUATS. Recently airlines use of bulk store has diminished, in favor of filing daily flight plans, which take the forecasted winds into account.

DUATS Direct User Access Terminal Service provides current weather and flight plan filing services to authorized civil pilots, the US Coast Guard, and some airlines. Weather briefings can be tailored to users needs. This service reaches the HOCSR FDP via NADIN 1A Service B interface.

Military Operations Military flight plans are filed by the base operations personnel on the military bases. Base operations is serviced by a computer within the ARTCC reachable via dial-up phone lines, which then communicates with the HOCSR FDP via NADIN 1A Service B interface.

Controllers Controllers and other ATC personnel also have the capability to enter a flight plan into the HOCSR FDP computer.

TRACONs and Neighboring ARTCCs Flight plans are also received from the neighboring ARTCCs FDP for flights that are scheduled to enter the ARTCCs airspace some time before transfer of control is to happen. The ARTS computer also automatically transfers flight plans to the HOCSR FDP for VFR flights.

ETMS At the time of filing the flight plan information is also forwarded to the Enhanced Traffic Management System (ETMS). The ETMS then sends the estimated departure clearance time (EDCT) for proposed flight plans.

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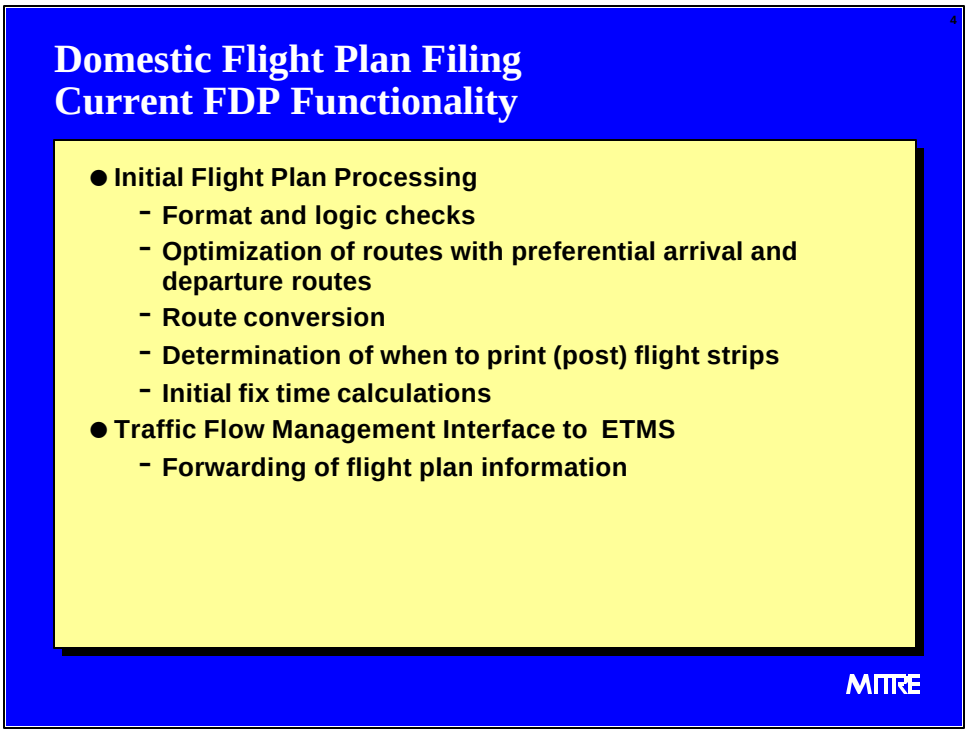

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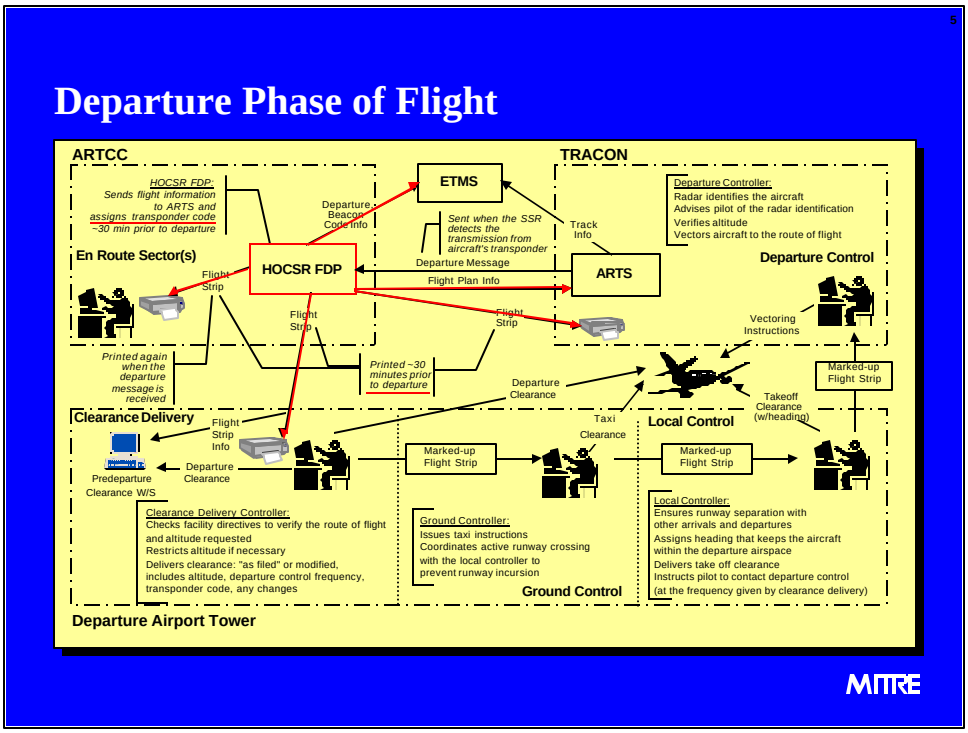

Clearance Delivery/Flight Strip Printing Thirty minutes prior to the aircraft's proposed departure time, the FDP computer causes a flight strip to be printed at the FDIO at the departure airport. If the departure airport is not served by an ATC facility, or if the facility is not FDIO equipped, the strip will be printed at the next closest facility. At this time, the FDP computer also assigns the aircraft a transponder code. Since the number of codes available is limited, this procedure is used to effectively ration transponder codes. Assuming that the aircraft is departing from an airport equipped with FDIO (such as Indianapolis International), the flight strip will be printed at clearance delivery position in the control tower. The clearance delivery controller is responsible for ensuring that the aircraft's altitude and route of flight conform to the appropriate letters of agreement and facility directives. The controller can then issue the clearance to the pilot. In most cases, facility directives specify that the aircraft be initially restricted to an altitude lower than that filed by the pilot. If the controlling facility has responsibility for the airspace extending up to 10,000 feet, for example, clearance delivery controller must initially restrict the aircraft to this altitude so that in case of temporary radio failure the aircraft does not leave the vertical confines of the facility's airspace before a handoff has been accomplished. At some facilities, additional constraints have been imposed on departing aircraft. It is not unusual to restrict an aircraft to an initial altitude of 3,000 to 6,000 feet. The clearance delivery controller must issue the pilot the clearance using one of two methods. If no changes were made to the pilot's requested route flight, the controller can clear the pilot "as filed". This means that the route that the pilot filed is the same route as that contained in the clearance. However, the altitude must always be stated by the controller even when issuing an "as filed" clearance to the pilot. If the altitude is restricted, controller advises when a clearance for the requested altitude can be expected. The departure clearance also includes the departure control frequency, and the transponder code.

Predeparture Clearance PDC provides a data service for delivery of the initial IFR clearance to the pilot through airline hosts relieving the overload on the clearance delivery frequency during busy departure hours at certain airports. PDC also provides an interface to the clearance delivery controller containing a list of participating flights, a flight strip image for the flight the controller is working with, prompts for site adapted local data to complete the clearance, delivery status of a clearance issued to the airline hosts. A recallable history of all clearances processed is also maintained. PDC clearance is delivered to the flight deck or to an airline printer at the departure airport depending on airline operations.

Ground Control The ground controller is responsible for issuing a taxi clearance that will take the aircraft to the departure end of the appropriate runway. The ground controller is also responsible for any vehicles that must travel on the airport movement area. If the aircraft must cross an active runway before reaching the departure runway, the ground controller must coordinate this crossing with the local controller. This is accomplished by asking the local controller for permission to cross the active runway at a certain location. The local controller may either approve the request, deny it, or approve it subject to some restrictions. After the aircraft has crossed the runway, the ground controller must advise local controller that the operation has been completed.

Local Control It is the local controller's responsibility to provide runway separation for all aircraft arriving and departing while still complying with any departure instructions issued by the departure controller. The local controller is not permitted to depart IFR aircraft without the approval of the departure controller. This approval may be received specifically for each aircraft, or routine departure instructions may be specified in the facility directives. Most radar-equipped facilities have devised a system that permits the local controller to depart an IFR aircraft without prior coordination with the departure controller. This method of operation requires that a specific block of airspace be reserved for departing aircraft; the local controller is authorized to depart aircraft into this area without prior coordination. The local controller still retains responsibility for the initial separation of IFR departures. When using this type of system, it is the responsibility of the approach controllers to keep inbound aircraft separated from this departure area. In most situations, the local controller pencils the aircraft's heading on the appropriate flight progress strip, then sends the strip via a tube that guides it directly to the appropriate departure controller's workstation. Once the local controller has departed the aircraft and resolved any conflicts with local traffic, the pilot is directed to contact the departure controller. Since the appropriate frequency was issued by the clearance delivery controller, the local controller is not required to repeat it.

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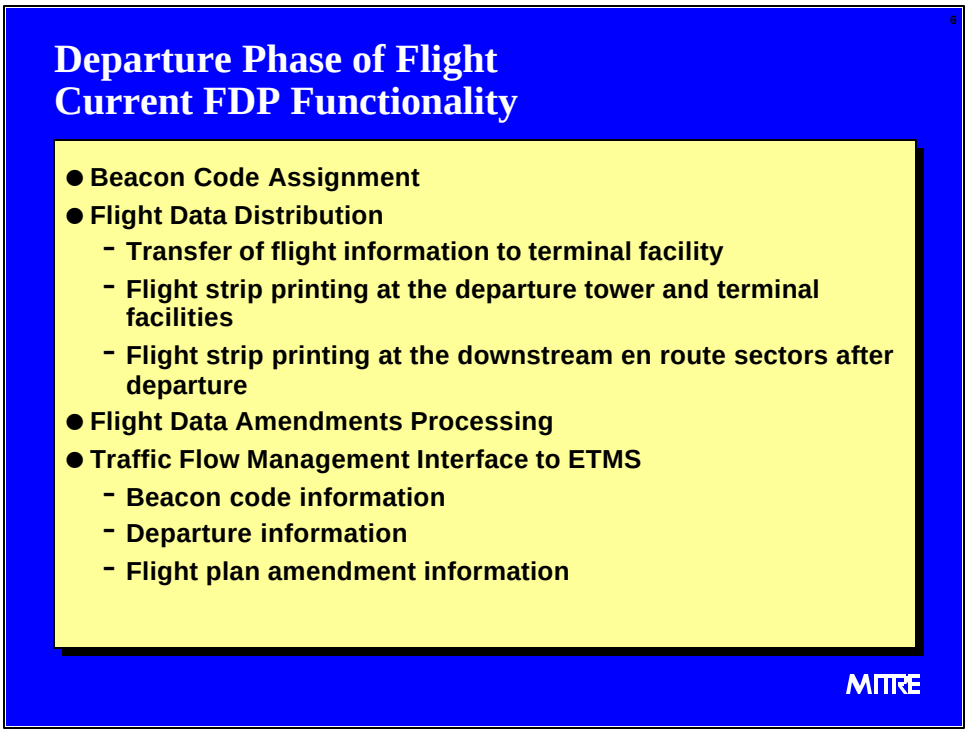

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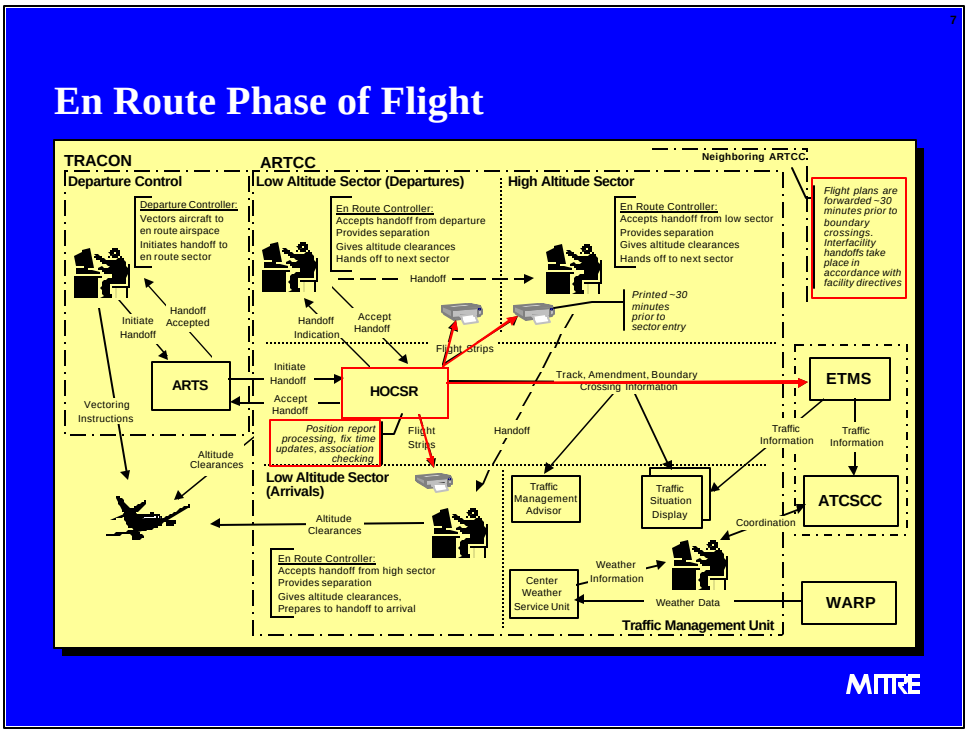

Departure Control Depending on the complexity of the facility, departure control may be operated by the approach controller, might be a separate control position, or might even be divided into a number of different subsectors. It is the departure controller's responsibility to separate this aircraft from all others while still complying with the appropriate facility directives and letters of agreement. If the facility is equipped with ARTS radar, the ARTS computer detects the aircraft's transponder transmission and automatically sends a departure message to the ARTCC computer. Departure controller must radar identify the aircraft and verify the accuracy of the aircraft's mode C transponder, if the aircraft has one. The departure controller advises the pilot that radar contact has been established. If the pilot has not stated the altitude of the aircraft, the controller must ask the pilot for altitude verification before using the altitude readout for aircraft separation. The controller vectors the aircraft to join the route of flight while still complying with facility directives and letters of agreement. The controller also attempts to clear the aircraft to climb to the pilot's requested altitude as soon as is practical. If this is not possible because of a lack of jurisdiction or traffic conflicts, the aircraft will normally be cleared to the altitude closest to that filed by the pilot. If the aircraft will transit other subsectors within the terminal facility, it is the departure controller's responsibility to either handoff or point out aircraft to the appropriate controllers. Such handoffs are accomplished manually or through the use of automated procedures. If the aircraft is remaining at a fairly low altitude, it will usually be handed off to an adjoining terminal facility. But if the aircraft will fly at a sufficiently high altitude, it is normally handed off to the appropriate ARTCC.

En Route Procedures The first en route controller providing separation service receives a progress strip shortly after the clearance delivery controller enters the departure time into the FDIO (or after the ARTS computer detects the aircraft's transponder and sends a message directly to the ARTCC computer). Subsequent controllers receive updated flight progress strips approximately 15 to 30 minutes before the aircraft enters each sector. The en route controllers use the information on the flight strip to prepare for the separation of that flight. Once the ARTCC radar system detects the aircraft's transponder signal, a data block containing the aircraft's call sign, altitude, and airspeed appears on the controller's display. At the point delineated in the appropriate letter of agreement, the departure controller hands off the aircraft to the ARTCC controller. Once the en route controllers have accepted a handoff, it is their responsibility to separate that aircraft from all others within the sector. This may be somewhat difficult if the aircraft is sufficiently low and far enough away from an ARTCC radar site that it remains undetected by radar. In such cases, the aircraft will not appear on the ARTCC controllers' radar display and must be separated using nonradar procedures. The responsibility for this separation lies with the radar associate/nonradar controller. Once the aircraft is detected by radar; however; separation responsibility is that of the radar controller. Generally, if the aircraft is operating below 18,000 feet MSL, it is separated by controllers responsible for low-altitude aircraft (known as low-sector controllers). But if the aircraft climbs to a higher altitude, it must be handed off to a high-altitude control sector. In certain areas there are also super-high and super-low sectors. Once the aircraft reaches its assigned cruising altitude, it continues toward its destination, being handed off from controller to controller as it crosses sector boundaries.

Traffic Management Unit Enhanced Traffic Management System (ETMS) gathers, and aggregates data for forming a national view of air traffic. ETMS serves airlines, TMUs at ATC facilities, and the Air Traffic Control System Command Center (ATCSCC) in Herndon, VA. Data is collected at the ETMS hub (located at the Volpe National Transportation Systems Center (VNTSC) in Boston, MA). HOCSR sends updates every five minutes, ARTS sends updates every minute. ETMS sends integrated traffic information back to the facilities and to ATCSCC to be displayed on Traffic Situation Displays. TMU Positions: En Route Spacing Program Coordinator, Arrival Sequencing Program Coordinator, Departure Sequencing Program Coordinator, Traffic Management Coordinator in Charge, Traffic Management Area Coordinator, Mission Coordinator, Weather Coordinator, Traffic Management Analyst. TMU personnel perform local traffic planning supporting controllers, coordinate with neighboring ARTCCs via Air Traffic Control System Command Center (ATCSCC) in Herndon. The traffic management function also includes sector management. In addition to the HOST Metering function, some Traffic Management Coordinators (and En Route Controllers) get metering information from the Traffic Management Advisor (TMA) prototype which provides traffic flow visualization to TMC and advisories to controllers.

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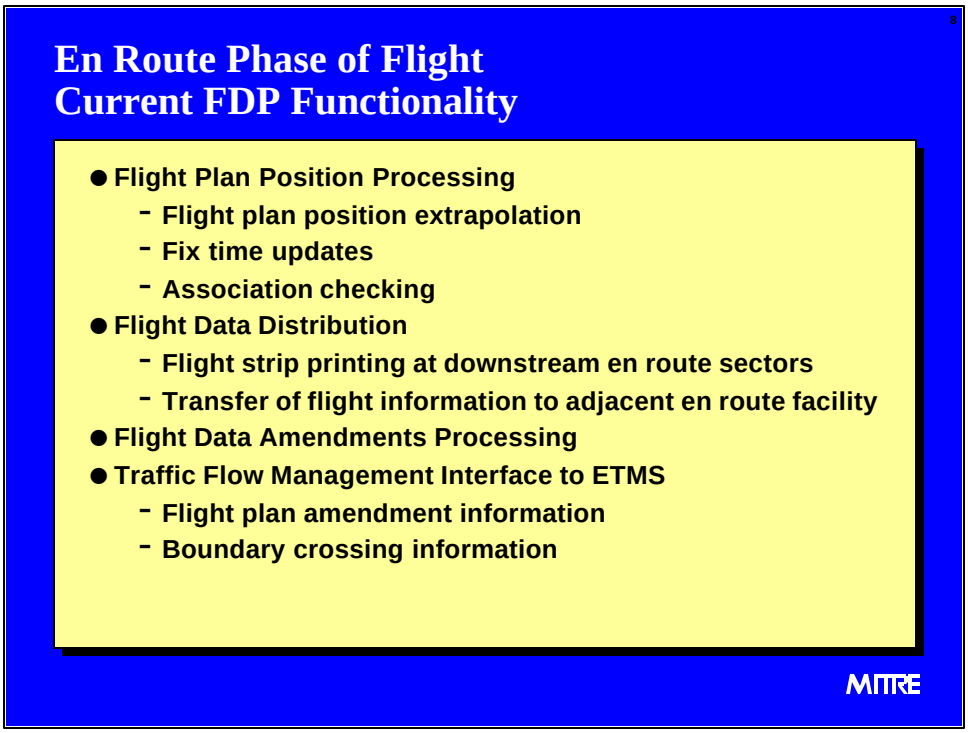

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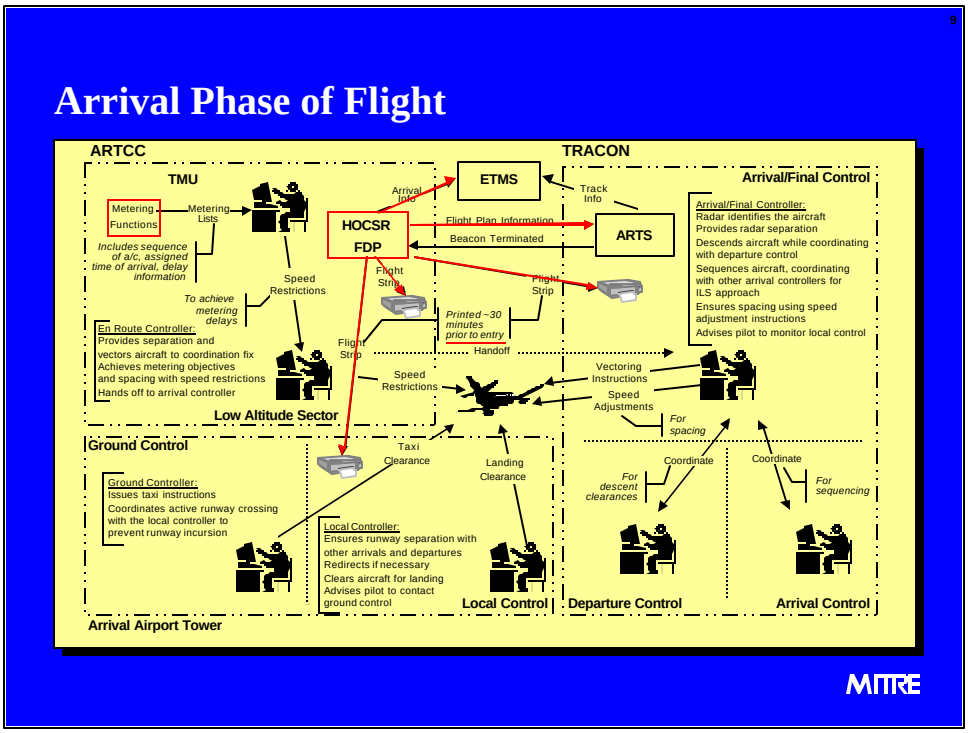

En Route Metering As aircraft approach the destination airport, each successive controller begins to assign progressively lower altitudes to it. If the arrival airport is particularly busy, en route metering may be in effect. En route metering attempts to match the inbound flow of traffic to the airport's acceptance rate, the calculated rate at which the airport can absorb traffic. If, for instance, calculations show that a particular airport can handle 60 aircraft operations in one hour, its theoretical acceptance rate is 1 per minute. A general rule of thumb is that a single runway can handle 30 arrivals per hour (one every 2 minutes) if the runway is being used for both arrivals and departures. If the runway is being used solely for arrivals, a 1-minute interval between aircraft can probably be maintained. This would permit the runway to handle 60 aircraft per hour.

If two aircraft are scheduled to arrive at the airport at the same time, one of the aircraft will have to be delayed for at least 1 minute. Such delays place a burden on the approach controller, since only a limited amount of airspace is available to maneuver aircraft. It becomes even more difficult to delay aircraft when more than two flights are scheduled to arrive at the same time. In this situation, the approach controller rapidly runs out of airspace in which to maneuver aircraft (a fairly common situation that occurs routinely wherever airlines operate hub-and-spoke scheduling systems).

The en route metering program calculates the airport's acceptance rate and determines the number of aircraft that can be handled in any given 5-minute period. If it is determined that the calculated airport acceptance rate will be exceeded, the en route metering software at the ARTCC begins to calculate appropriate delay strategies to temporarily reduce the number of aircraft inbound to the airport. The metering program prints out specific times that aircraft should cross en route fixes in order to delay each aircraft the required interval. It then becomes each ARTCC radar controller's responsibility to ensure that the aircraft cross these fixes at the appropriate times. This is usually accomplished by temporarily reducing each aircraft's speed. In most cases the metering fixes are approximately 50 to 100 miles from the destination airport.

Approach Control At radar-equipped terminal facilities, it is the approach controller's responsibility to sequence and separate inbound aircraft. At low-activity towers, this task may be delegated to only one controller. At high-activity airports, approach control duties may be assigned to up to five different types of controllers:

(1) feeder controllers, whose responsibilities are to sequence arriving aircraft toward the final approach course; (2) a final controller, whose responsibility is to sequence aircraft on the instrument approach; (3) a monitor controller, who continuously monitors aircraft conducting parallel ILS approaches; (4) satellite controllers, who handle approaches and departures from low-activity airports located within the primary airport's approach control area of jurisdiction; and (5) departure controllers, who separate aircraft departing from the primary airport.

Approach controllers, also referred to as arrival controllers, are responsible for providing radar separation to the aircraft while sequencing and spacing for landing. The arrival controllers coordinate with departure controllers while descending the aircraft. In busier areas where there is more than one arrival position, arrival controllers coordinate among themselves for sequencing aircraft into the same runway. Arrival controllers issue speed restrictions to achieve the desired spacing between aircraft sequenced for arrival. If an instrument landing system is in use, arrival controllers vector aircraft to successfully intercept the ILS final approach course.

Local Control It is the local controller's responsibility to clear the aircraft for landing while coordinating with other arrivals and departures. Once the aircraft has landed safely and clears the runway, local controller advises the pilot to contact ground control.

Ground Control The ground controller is responsible for issuing a taxi clearance that will take the aircraft to the terminal while coordinating with the local controller for active runway crossings.

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Arrival Phase of Flight
Current FDP Functionality

- Metering Functions
  - En Route Spacing Program (ESP)
  - Arrival Sequencing Program (ASP)
- Flight Data Distribution
  - Transfer of flight information to terminal facility
  - Flight strip printing at the arrival terminal and tower facilities
- Beacon Code Termination
- Flight Plan Termination
- Traffic Flow Management Interface to ETMS
  - Arrival information

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IFR Flight Example

- Reference: Fundamentals of ATC, M.S. Nolan, Chapter 10, Operation in the NAS
- Three flight legs
  - From Lafayette, IN to Champaign, IL
  - From Champaign, IL to Indianapolis, IN
  - From Indianapolis, IN to Lafayette, IN
- Characterization of the flight from Lafayette to Champaign
  - No FDIO equipment in the departure tower and terminal facilities
  - Arrival airport is in neighboring ARTCC's airspace
  - Flight travels through terminal airspace only

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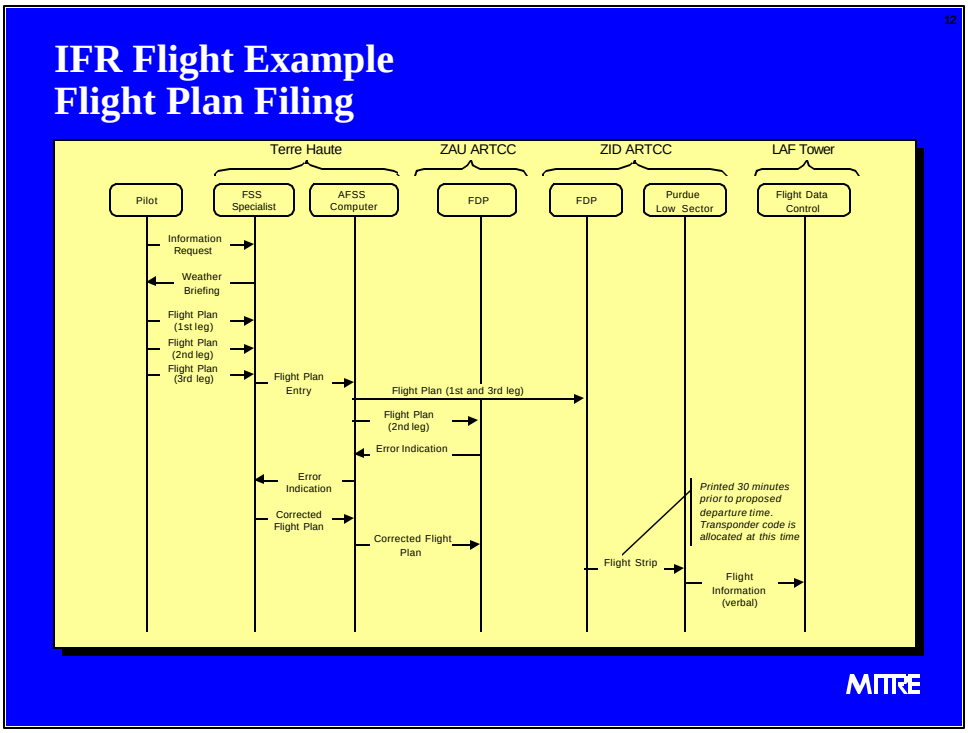

Lafayette to Champaign

Flight Plan Filing

The pilot initially contacts a flight service station to receive a weather briefing and file an IFR flight plan. In this particular flight, the pilot would probably contact the Automated Flight Service Station in Terre Haute, Indiana. The flight service specialist at Terre Haute would conduct a weather briefing for the pilot and would then request the appropriate flight plan information. In this example, it is assumed that the pilot files a separate flight plan for each of the three legs of the flight. As the pilot passes along the appropriate information to the FSS specialist, it is entered directly into the FSS computer.

Once the briefing is finished, the FSS computer transmits the information to the flight data processing computer at the appropriate ARTCCs. Because Lafayette and Indianapolis are within the boundaries of Indianapolis ARTCC the information for the first and third legs of the flight is transmitted to Indianapolis ARTCC. But since Champaign is located within Chicago Center's airspace, the flight plan information for the second leg is transmitted to the Chicago ARTCC computer.

The HOCSR FDP computer examines the route information contained in the plan and verifies its accuracy. If it is in error a message is sent to the Terre Haute flight service specialist, who must determine the routing error and make the required corrections. If any changes are made to the route of flight, the specialist causes the abbreviation FRC to be printed on the strip.

The HOCSR FDP computer also checks the routing information in the flight plan and checks to see whether any preferred arrival or departure routes apply to this flight. If so, they are automatically printed on the flight progress strip. Half hour prior to the pilot's estimated time of departure, the HOCSR FDP computer activates the flight plan, issues the aircraft a transponder code, and causes a flight progress strip to be printed. Since the Lafayette control tower is not equipped with FDIO printers, the flight strip will be printed at the Indiana ARTCC sector directly above Lafayette approach control's airspace, the Purdue Low Sector.

The flight data controller at the Purdue Low Sector contacts the flight controller at Lafayette tower and verbally passes along the information contained in the flight plan. This includes the aircraft call sign, aircraft type, transponder code, proposed departure time, requested altitude, destination airport and route of flight. If the route is lengthy, normally only the segment of the flight plan that concerns Lafayette tower will be passed along.

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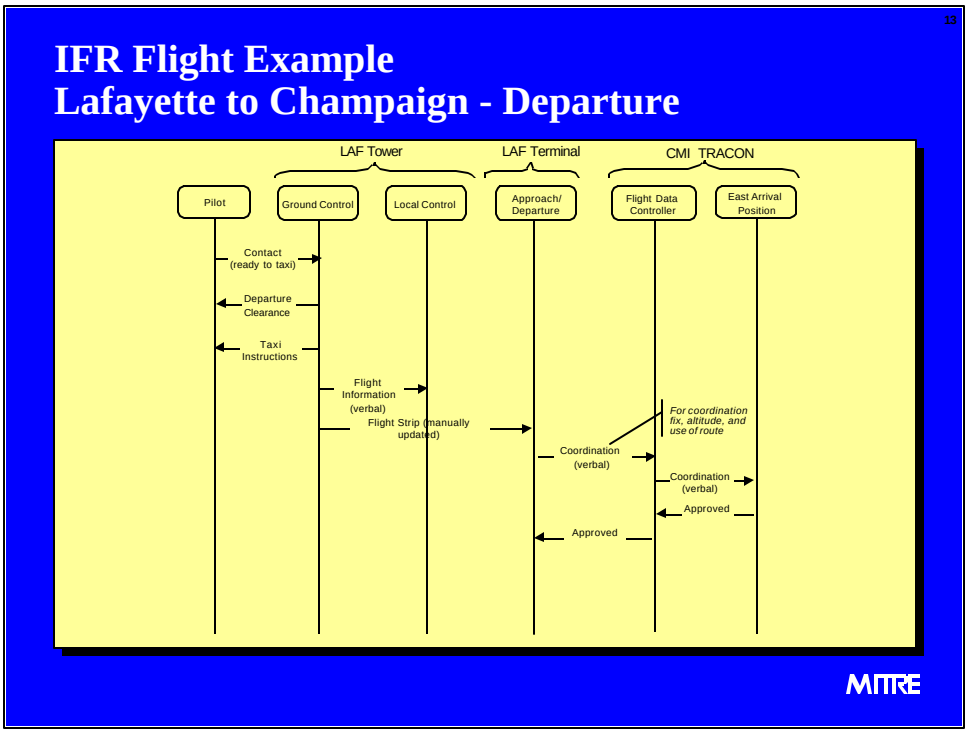

Lafayette Ground Control

The pilot next contacts the ground controller at Lafayette for taxi instructions and IFR clearance, and the controller issues appropriate taxi instructions. If the pilot has requested a route not approved by the letter of agreement between Lafayette and Champaign, the controller will change the route of flight to conform to the LOA, then read the clearance to the pilot. The phraseology would be as follows:

N252MN cleared to the Champaign airport as filed via victor two fifty one, climb and maintain five thousand. Departure control frequency one two three point eight five. Squawk four two one two.

The ground controller passes the flight strip to the approach controller; who also handles the duties of the flight data and departure controllers. The ground controller verbally advises the local controller that N252MN is an IFR departure and that further coordination with the approach controller must be accomplished before N252MN can be released.

Lafayette Approach Control

Next, the Lafayette approach controller contacts Champaign approach using the telephone. The flight data controller in the TRACON at Champaign usually answers. The Lafayette controller requests approval for N252MN to enter Champaign's airspace at 5,000 feet. The Lafayette controller requests the use of V251 and specifies that the transfer of control and communication will occur at the Staks intersection (which is the boundary between the two facilities). At this time, the Champaign flight data controller verbally communicates with the east arrival controller, who has responsibility for the airspace over Staks, and passes along Lafayette's request. Depending on traffic conditions (particularly at the Danville airport, which is almost directly under V251), the east arrival controller will approve the route and altitude or will request specific changes in either:

LAFAYETTE CONTROLLER: APPREQ, N252MN victor two fifty-one at Staks at five thousand.

CHAMPAIGN CONTROLLER: N252MN at Staks at five thousand approved.

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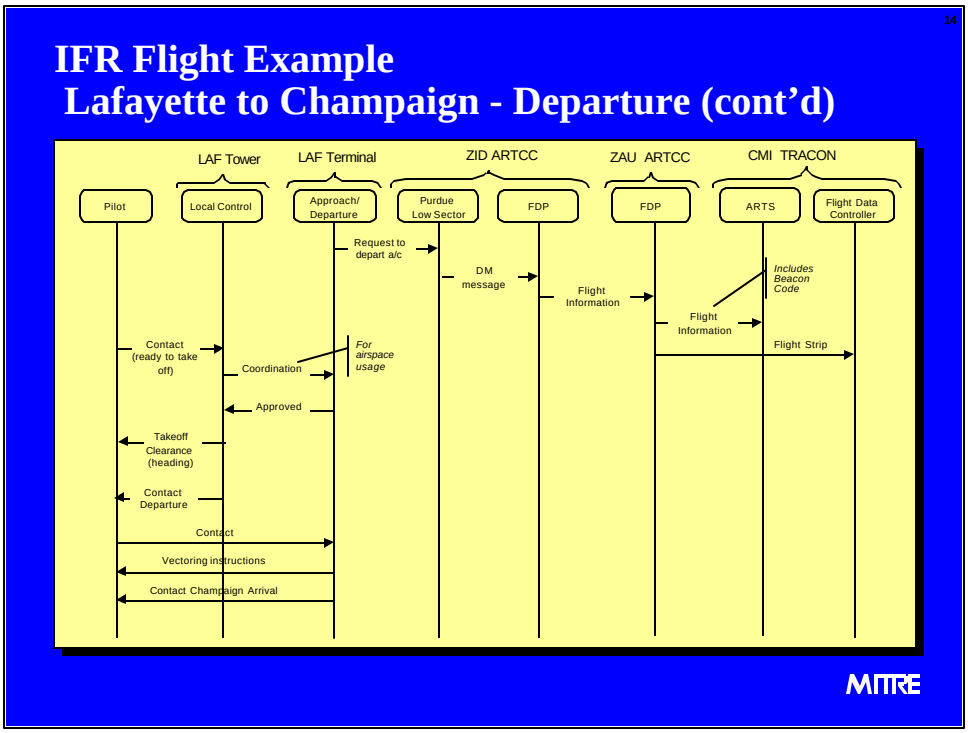

Lafayette Approach Control (continued)

The approach controller then contacts the flight data controller at the Indianapolis ARTCC to request that N252MN be departed in the HOCSR FDP computer. The flight data controller at the Purdue sector enters a departure message into the FDIO. Entering a departure message causes the appropriate flight plan information be sent to the next ATC facility (Champaign), which will handle the aircraft. Since Champaign is not in Indianapolis Center's airspace, the flight plan information is first sent to the Chicago ARTCC computer, which automatically forwards this information to Champaign. A flight progress strip is then printed at Champaign, and the appropriate beacon code information is transmitted to the Champaign ARTS computer.

Lafayette Local Control

The local controller must ensure proper separation between this aircraft and any other IFR or VFR aircraft departing from Lafayette. In addition, the local controller must contact the approach controller to ensure that N252MN is separated from aircraft within Lafayette's assigned airspace. When the pilots advise the local controller that they are ready for takeoff, the local controller coordinates the departure with the approach controller, who may request a slight change in route or altitude to separate N252MN from other IFR aircraft. If there is insufficient airspace to accommodate N252MN at this time, departure controller may advise the local controller to "hold for release". This means that the aircraft must remain on the ground until sufficient airspace can be cleared to accommodate it. Once sufficient airspace is cleared the approach controller advises the local controller, who can then clear N252MN for takeoff as soon as local traffic conditions permit.

Once approval has been received to depart the aircraft, the controller sequences N252MN into the departure flow of aircraft, assigns a heading that will join the airway, and issues a clearance for takeoff. As soon N252MN clears any traffic in the local area, the local controller advises N252MN to contact the departure controller ("*N252MN turn right heading two seven zero, runway one zero, cleared for takeoff", "N252MN contact departure").*

The approach controller at Lafayette also performs the duties of the departure controller and is responsible for separating N252MN while ensuring that the aircraft conforms to the clearance received from Champaign. To conform with the letter of agreement, N252MN must be established on V251 and level at 5,000 feet before crossing Staks ("*N252MN, join victor two fifty one, cross Staks at and maintain five thousand*").

Once N252MN reports crossing Staks, Lafayette approach advises the pilot to contact Champaign approach ("*N252MN contact Champaign approach on one two one point three five*").

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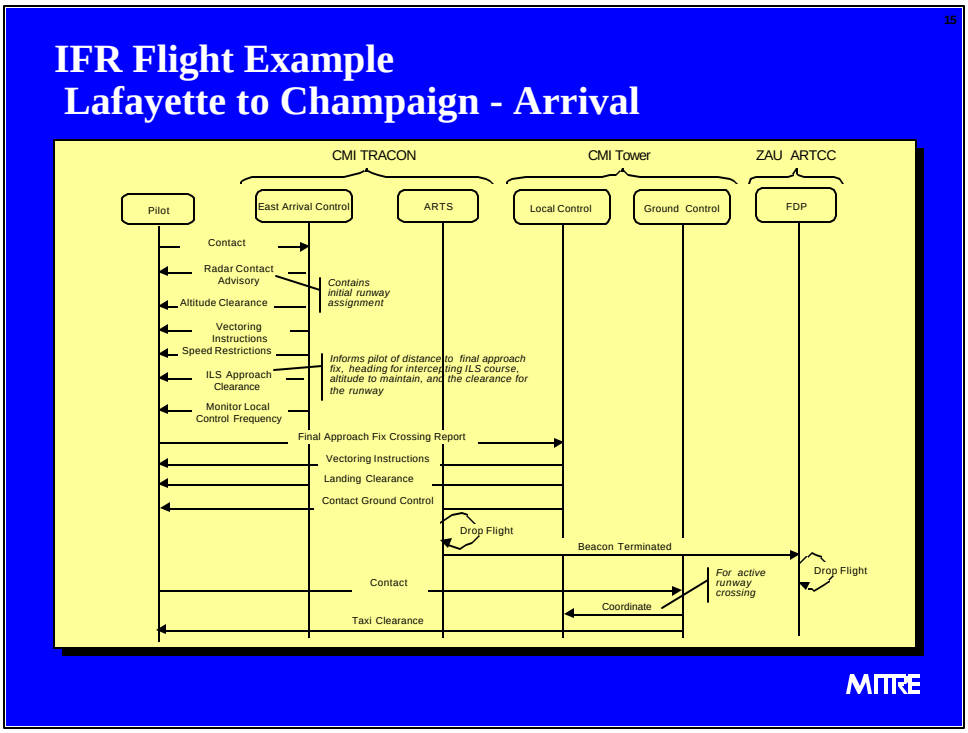

Champaign Approach Control The Champaign Air Traffic Control Tower is an ARTS, radar-equipped facility at a medium-activity airport. It is assumed that the controller is vectoring for the ILS approach. Once the east sector controller has approved N252MN's entry into Champaign's airspace, nonradar separation must be provided until N252MN can be radar identified. When the aircraft has established communication with the Champaign controller after crossing the Staks intersection, the controller will radar identify the aircraft and begin to use radar separation. Most likely, the controller will use a combination of two or more of these methods, such as noting the reported location of the aircraft, observing the acquisition of the aircraft's transponder signal by the ARTS system, and requesting that the pilot activate the Ident function of the transponder.

The controller advises the pilot when radar contact has been established and then begins to apply radar separation procedures and offers standard radar services. The controller also assigns a new altitude and informs the pilot of the instrument approach that is to be expected ("*N252MN, radar contact three miles southwest of the Staks intersection, descend and maintain three thousand, expect vectors for the ILS runway three two left approach*"). The east controller issues vectors (and speed restrictions if needed) to N252MN ("*N252MN fly heading two one zero, vector for the ILS runway three two left approach*"). Whenever one of these instructions is issued to the pilot, the controller should advise the pilot of the reasons for the instruction.

The controller must position the aircraft such that an easy transition can be made to the ILS final approach course. The controller is required by the FAA handbook to maneuver the aircraft so that it can intercept the ILS localizer at a point at least 2 miles outside the approach gate, at an angle of less than 30 degrees, and at an altitude that will permit the aircraft to descend safely and intercept the glide slope. Since the final approach fix (Veals) is 5.5 nautical miles from the approach end of the runway, the approach gate is at 6.5 nautical miles. The controller must vector the aircraft to intercept the localizer no closer than 8.5 nautical miles from the runway. The pilot can then be cleared for the ILS approach. As part of the approach clearance, the controller must advise the pilot of the aircraft's position relative to the final approach fix, the heading to fly to intercept the final approach course, the altitude to maintain until established on the final approach course, and the actual clearance to conduct the instrument approach ("*N252MN, six miles from Veals, turn right heading three zero zero, intercept the localizer at or above two thousand six hundred, cleared for ILS runway three two left approach. Monitor tower on one two zero point four, report Veals inbound*"). Once the aircraft is established on the ILS, the pilot can be advised to monitor the local controller's frequency and report crossing the final approach fix.

Local Control When the aircraft has crossed the final approach fix, it becomes the local controller's responsibility to sequence it into the local traffic flow. The local controller must ensure that no instructions are issued to the aircraft that might cause it to conflict with any inbound or outbound IFR aircraft being maneuvered by the approach controllers. The controller does so by using the 3-nautical-mile area near the approach end of the runway. Champaign Facility Directives permit the local controller to maneuver N252MN once it enters this 3-mile area. The controller can maneuver N252MN to follow another aircraft or can clear N252MN to land on a different runway. The one restriction on the use of this area is that the local controller is not permitted to turn N252MN back toward following IFR aircraft. Once N252MN has been properly sequenced, the local controller can advise the pilot that the aircraft is cleared to land ("*N252MN, cleared to land runway three two left*"). After the aircraft has landed, the local controller advises the pilot to contact the ground controller for taxi instructions to the parking area ("*N252MN, if able, turn right at the next intersection, contact ground on one two one point niner*").

Ground Control The Champaign ground controller then issues N252MN a clearance to taxi to the parking ramp ("*N252MN, taxi to the ramp, transient parking is south of the tower*"). If N252MN must cross an active runway before reaching the parking area, the ground controller must coordinate this crossing with the local controller. Once the aircraft is on the ground, the ARTS computer is programmed to terminate the aircraft's flight plan and the appropriate flight plan information is expunged from the local ARTS and the Chicago ARTCC computer system.

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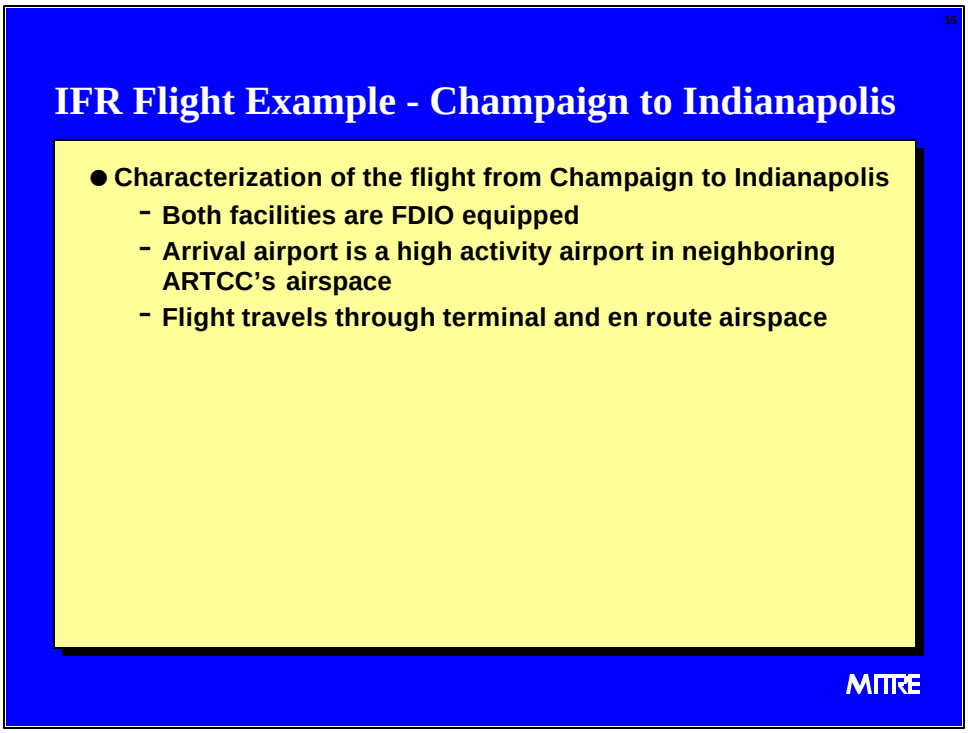

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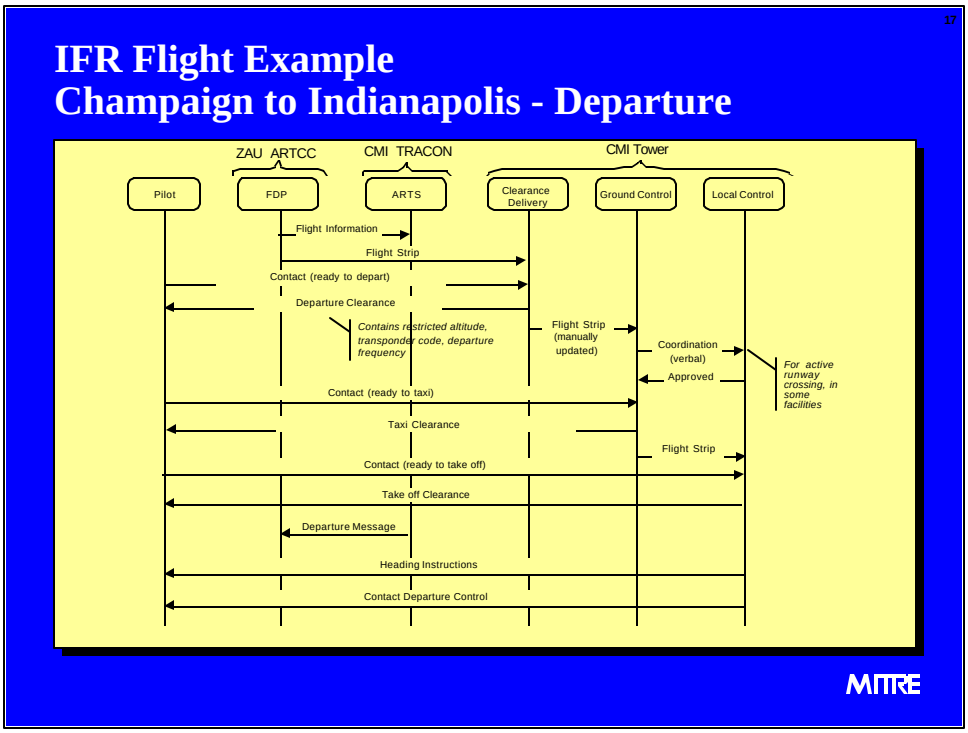

Champaign to Indianapolis

Clearance Delivery Thirty minutes prior to N252MN's proposed departure from Champaign, the appropriate flight plan data are transmitted from the Chicago ARTCC computer to the ARTS computer at Champaign. This causes a flight progress strip to be printed at the clearance delivery position in the tower cab at Champaign. Since Champaign is a fairly busy facility, a separate frequency has been assigned for use by the clearance delivery controller. When N252MN is ready to depart, the pilot first contacts the clearance delivery controller on this frequency. Before issuing the clearance to N252MN, the controller must ensure that the printed clearance conforms with the Letter of Agreement between Champaign tower and Indianapolis Center, since the aircraft will be flying at 12,000 feet, which is airspace assigned to Indianapolis Center. If any changes need to be made to the aircraft's route or altitude to conform with the Letter of Agreement, they are made by the clearance delivery controller and entered into the FDIO. The clearance delivery controller must also ensure that the clearance conforms with Champaign tower Facility Directives. In particular, at Champaign, the Facility Directives state that every departing aircraft will initially be assigned an altitude of 3,000 feet MSL, which is the upper limit of the airspace located at the departure end of the runway that has been delegated to the local controller. The clearance delivery controller is required to initially restrict every aircraft to this altitude and inform the pilot that the altitude filed in the flight plan can be expected later in the flight. ("*N252MN cleared to Indianapolis airport as filed, climb and maintain three thousand, expect one two thousand one zero minutes after departure. Departure frequency is one two one point three five. Squawk four one two one*").

Since Champaign is equipped with an ARTS radar system, the clearance delivery controller does not need to send a departure message to the HOCSR FDP computer at Chicago Center. Champaign's ARTS computer sends a departure message to the HOCSR FDP computer in Chicago upon receipt of N252MN's transponder code. When the clearance is issued by the clearance delivery controller, the flight progress strip is passed to the ground controller.

Ground Control When the pilots have received their clearance, they contact the ground controller for taxi instructions to the active runway, which in this example will remain runway 32L ("*N252MN, turn left on the parallel taxiway, follow the DC-9, taxi to runway three two left*"). If the aircraft must cross any active runways en route to 32L, the crossing must be coordinated with the local controller.

Local Control When the pilot is ready for takeoff, radio contact is established with the local controller. The local controller is responsible for sequencing N252MN into the local traffic flow while also providing initial IFR separation between departures. ("*N252MN, turn right heading three five zero, runway three two left, cleared for takeoff*"). It is up to the approach controller to keep arriving aircraft clear of the departure area.The local controller is permitted by the Facility Directives to depart IFR aircraft within this departure area without prior coordination with the departure controller as long as certain conditions are met. Once the local controller has ensured that these conditions have been met, the pilot is informed to contact the departure controller ("*N252MN, contact departure*").

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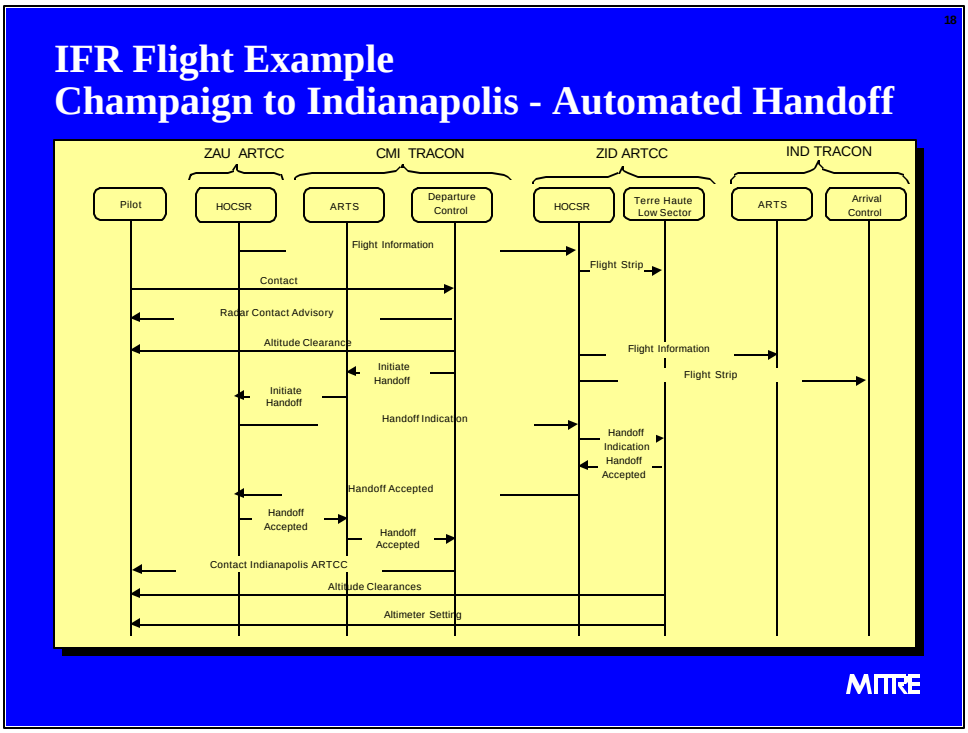

Departure Control Flight strips are printed at every en route sector that N252MN will fly through by the HOCSR FDP computer. Since N252MN will be entering the airspace assigned to Indianapolis ARTCC, the appropriate flight plan information is transmitted to the HOCSR FDP computer at Indianapolis Center. At Champaign, the east and west approach controllers are also responsible for the separation of aircraft departing Champaign. Upon initial contact with N252MN, the east departure controller is required to perform certain checks before he/she can advise N252MN that it has been radar identified and vector the aircraft to join the proper airway (victor 434). As soon as traffic permits, the controller will authorize N252MN to climb higher than the 3,000 feet initial restriction ("*N252MN, radar contact, turn right heading one two zero, join victor four thirty-four, climb and maintain eight thousand*"). At no time may the aircraft be cleared to an altitude higher than 8,000 feet MSL, however, since that is the upper limit of Champaign's delegated airspace.

Once the aircraft has joined victor 434 and is climbing to or level at 8,000 feet, and every potential traffic conflict has been resolved, the Champaign departure controller can initiate an automated handoff with Indianapolis Center (any deviation from the facility agreement for these procedures requires verbal coordination between the two controllers). This handoff must be accomplished before N252MN reaches the facility boundary. If it cannot be accomplished before the aircraft reaches that point the Champaign controller must ensure that N252MN remains within the confines of Champaign's airspace until a handoff or an alternative clearance can be coordinated. Typically, the handoff with Indianapolis Center is accomplished somewhere around the Emtee intersection, which is 12 miles east of Champaign. The Champaign controller initiates a handoff by slewing the ARTS trackball symbol over N252MN's radar blip and pressing the appropriate keys. This action automatically initiates the handoff process. Since Champaign is primarily located under Chicago Center's airspace, the electronic transmissions that perform this automated handoff actually travel from the Champaign TRACON to Indianapolis ARTCC via the Chicago Center computer. At Indianapolis Center, at the Terre Haute Low Sector, N252MN's data block begins to flash on the controller's display. If the Indianapolis Center radar controller decides to accept the handoff, the trackball symbol is slewed over N252MN's data block and the center controller presses the appropriate keys. N252MN's data block then ceases to flash on the center controller's display but starts to flash on the Champaign approach controller's radar screen, at which time the Champaign controller understands that the Indianapolis Center controller has accepted the handoff. The Letter of Agreement also specifies that Champaign must transfer the communication of N252MN before it reaches the boundary of Champaign's airspace ("*N252MN, contact Indianapolis Center one three two point two*"). This permits the ARTCC controller to be in radio contact with the aircraft before it actually enters Indianapolis Center's airspace. If it becomes apparent that N252MN will cross the boundary between Champaign and the Terre Haute TRACON at an altitude below 8,000 feet MSL, permission for N252MN to enter Terre Haute's airspace must be received from the Terre Haute approach controller.

Indianapolis Center The Indianapolis Center controller is not required to reidentify the aircraft, since initial radar identification was accomplished by the Champaign departure controller and was subsequently transferred during the automated handoff. All that is required of the center controller is to verify the accuracy of the aircraft's mode C readout, issue the pilot any altitude changes, and issue the altimeter setting from the closest airport with a weather observer ("*N252MN, climb and maintain one two thousand, Terre Haute altimeter two niner eight four*").The Indianapolis ARTCC controller is then responsible for separating N252MN from other IFR aircraft within the Terre Haute Low Sector while also complying with internal Facility Directives that may affect that flight. The center controller must also sequence N252MN into the traffic flow for the Indianapolis airport. The controller must comply with the procedures described in the Indianapolis Center/Indianapolis Tower Letter of Agreement. In particular, the Indianapolis Center controller must ensure that N252MN enters the Indianapolis approach control airspace either at or descending to 11,000 feet and enters over one of the designated arrival fixes. The Antti intersection, which is 21 miles west of the Indianapolis VOR on victor 434, is one such fix.

Approximately 30 minutes before N252MN enters Indianapolis approach control's airspace, the appropriate flight plan information is transmitted to the ARTS computer at Indianapolis TRACON.

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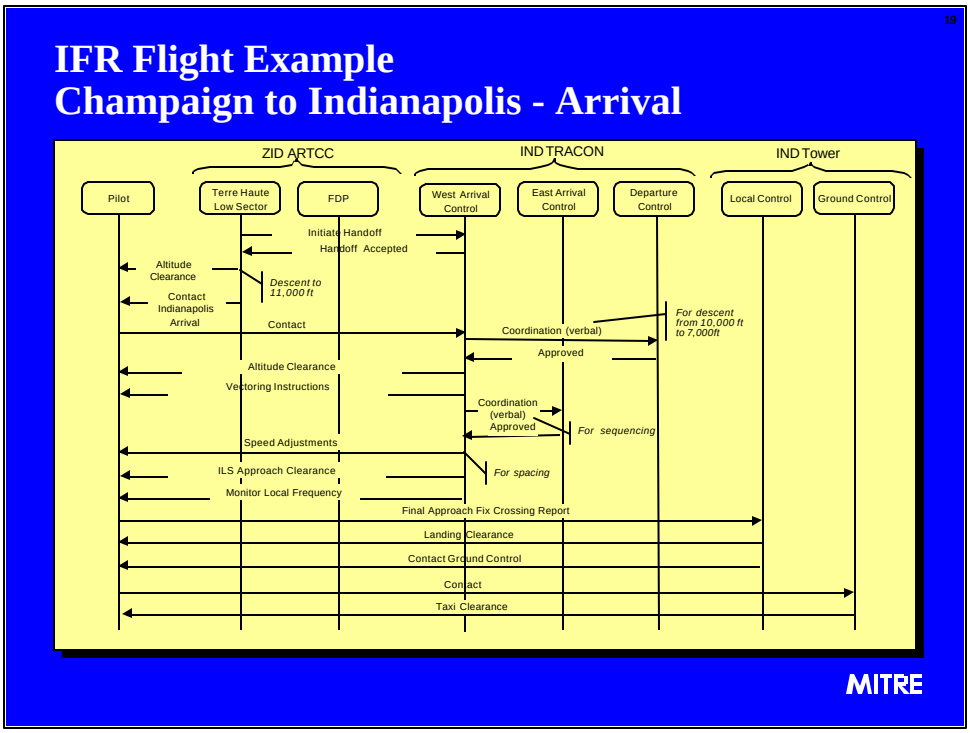

Handoff to Indianapolis Approach Indianapolis TRACON controllers procedurally separate inbound and outbound aircraft using a modification of a "box" system of procedural separation. In a typical box configuration, the Letter of Agreement describes a box that is drawn around the affected TRACON's airspace. Each corner of the box (known as a cornerpost) is delineated by an intersection or navaid. Where box systems are used, the Letter of Agreement specifies that every inbound IFR aircraft must enter the approach control's airspace at one of the cornerposts. These areas are known as arrival gates. The Letters of Agreement also specify that departures must remain clear of the cornerposts and depart the area through the sides of the box. The sides of the box are known as departure gates.

Once N252MN is detected by the secondary radar system at Indianapolis tower, the ARTS computer initiates a computer track. As N252MN nears the boundary between Indianapolis ARTCC and Indianapolis approach, the ARTCC controller initiates a handoff. When the handoff has been accepted by the Indianapolis approach controller, N252MN is descended to 11,000 feet and is advised to contact the approach controller ("*N252MN, descend and maintain one one thousand, contact Indianapolis approach control on one two one point one*").

Indianapolis Approach Control Since Indianapolis tower is located at a high-activity airport, it is not possible to simply divide the approach control airspace into two sectors as is done at Champaign. The Facility Directives at Indianapolis specify that as many as six different controllers may be assigned approach and departure control responsibilities, corresponding to six control sectors. Normally every inbound aircraft crosses one of the cornerposts either level at or descending to 11,000 feet. Once the aircraft has entered Indianapolis TRACON's assigned airspace, the arrival controller is permitted to descend the aircraft to 10,000 feet. Every aircraft inbound to Indianapolis is vectored toward the airport and sequenced behind other inbound aircraft. Once the aircraft is within about 15 nautical miles of the airport, the arrival controller is authorized to descend the aircraft to 7,000 feet if coordination has been accomplished with the appropriate departure controller ("*N252MN, descend and maintain seven thousand, vector for the ILS runway four left approach*"). When N252MN is within about 7 miles of the airport, the arrival controller may utilize the airspace extending from 7,000 feet to 3,000 feet MSL. At this point the aircraft is normally turned outbound, parallel to the ILS final approach course. Once in this position, traffic permitting, the aircraft will be descended to 3,000 feet in preparation for the ILS approach ("*N252MN, turn right heading two two zero, descend and maintain three thousand*"). As the aircraft flies this extended downwind pattern, the west arrival controller must coordinate with the east arrival controller to establish N252MN's sequence. When the sequence has been agreed on, the west controller will vector N252MN to follow the preceding aircraft, and if needed, the controller may issue the aircraft a speed adjustment that will maintain proper separation ("*N252MN, reduce speed to one seven zero*"). When N252MN is in the proper position, adequately separated from both preceding and following aircraft, the controller will turn the aircraft to intercept the runway localizer. Once the aircraft is turned inbound, it can be authorized to conduct the ILS approach ("*N252MN, seven miles from Pully, turn left heading zero seven zero, intercept the final approach course at or above two thousand eight hundred, cleared for the ILS runway four left approach. Monitor tower on one two zero point niner and report Pully inbound*").

Local Control At Indianapolis tower, the local controller is responsible for sequencing N252MN into the arrival flow of traffic but has little flexibility to maneuver the aircraft without coordinating with the controllers in the TRACON. If circumstances require, the local controller can clear N252MN to land on the parallel runway, runway 4R, but may not assign N252MN to any other runway without coordinating with the controllers in the TRACON ("*N252MN, cleared to land runway four left. Traffic is a Cessna ahead and to your right landing runway four right*").

Ground Control Once N252MN has landed, the local controller advises the pilot to Contact the ground controller, who clears the aircraft to taxi to the parking ramp.

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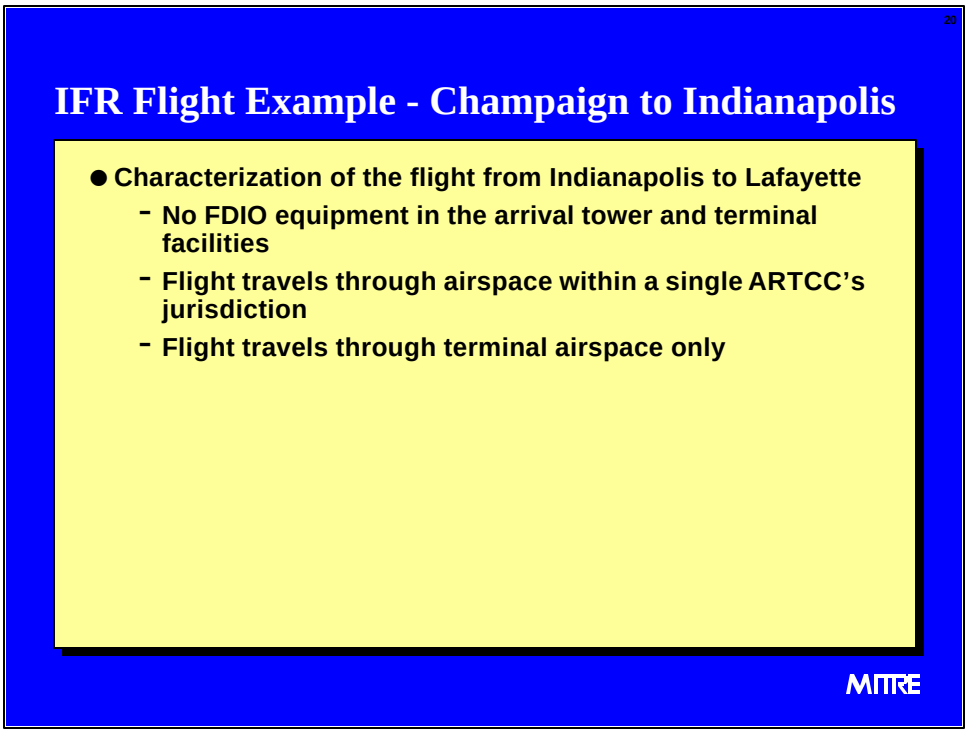

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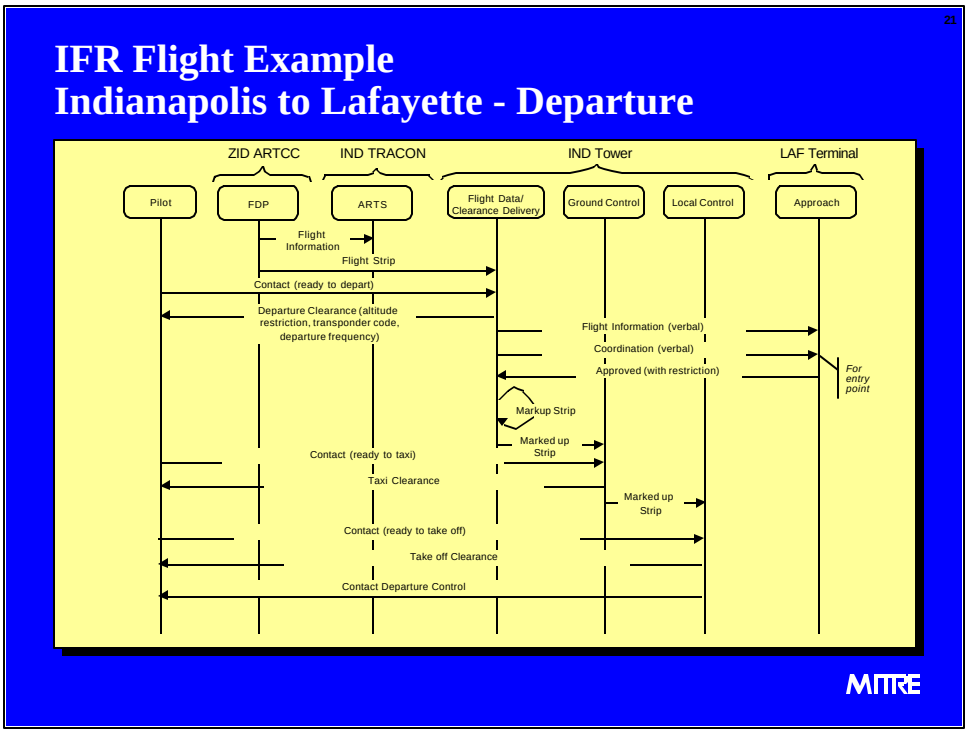

Indianapolis to Lafayette

Flight Data and Clearance Delivery Except when very busy, the flight data and the clearance delivery positions at Indianapolis tower are combined into one operating position. Approximately 30 minutes before N252MN's departure to Lafayette, the FDP computer at Indianapolis Center transmits the appropriate flight plan information to the FDIO and the ARTS-III radar computer at the Indianapolis tower. When the flight progress strip for N252MN is printed, the flight data controller must verify the accuracy of information contained in the flight progress strip and must initiate any changes that will make N252MN conform to the Lafayette Tower-Indianapolis Tower Letter of Agreement. The pilots of N252MN contact the clearance delivery controller to receive their IFR clearance. The controller issues the clearance as amended but initially restricts the aircraft's altitude to 2,500 feet, since at Indianapolis tower Facility Directives require that all propeller-driven aircraft initially be assigned an altitude of 2,500 feet, while pure jet aircraft are restricted to an initial altitude of 6,000 feet. These altitudes confine each aircraft to the local controller's departure fan. The clearance delivery controller issues a clearance that restricts N252MN to 2,500 feet, advising the pilots that they can expect their requested altitude (4,000 feet) 10 minutes after departure. In addition, the clearance delivery controller issues the appropriate departure control frequency ("*N252MN cleared to the Ockel intersection via victor ninety-seven, climb and maintain two thousand five hundred, expect four thousand one zero minutes after departure. Departure frequency one two one point seven five. Squawk four one five one*").

The clearance delivery controller then contacts the Lafayette approach controller using telephone equipment. Since Lafayette is a non-radar and non-FDIO facility, Indianapolis tower is required by Letter of Agreement to forward the appropriate flight plan information concerning N252MN and must also coordinate N252MN's entry into Lafayette's airspace. The Indianapolis controller advises the Lafayette controller of N252MN's route and altitude and its estimated departure time from Indianapolis. The Lafayette controller considers this request and then approves or disapproves it. As part of the approval, the Lafayette controller restricts the aircraft to an intersection located just within the boundary between Indianapolis and Lafayette (Ockel). Restricting N252MN to this intersection alleviates the need for the Lafayette controller to reserve a large block of airspace for N252MN:

INDIANAPOLIS CONTROLLER: APPREQ N252MN victor ninety-seven at four thousand, departing Indianapolis at one five three seven.

LAFAYETTE CONTROLLER: N252MN, Ockel via victor ninety-seven at four thousand approved.

When N252MN's entry into Lafayette's airspace has been approved, the clearance delivery controller at Indianapolis circles the altitude approved by Lafayette and places the estimated time of departure on the flight progress strip. This strip is then passed to the ground controller. When the pilot contacts ground control on 121.90 mHz, the ground controller issues the aircraft the appropriate taxi instructions and passes the strip to the local controller.

Local Control The local controller is responsible for sequencing N252MN into the local traffic flow while providing initial separation between departures. At Indianapolis, this is accomplished by assigning a departure fan to the local controller that varies in dimension depending on the type of aircraft departing. The upper limit of the departure fan for propeller-driven aircraft is 2,500 feet. The departure fan for jet aircraft is much smaller in width, and the local controller may issue jet aircraft only an initial heading of 40 degrees (runway heading). Jet aircraft are permitted, however, to climb unrestricted to an altitude of 6,000 feet. The variable size of the departure fan permits the local controller to issue diverging headings to slower aircraft and fairly high initial altitudes to jet aircraft without severely impinging on any aircraft being vectored by the controllers in the TRACON ("*N252MN turn left heading three six zero, runway four left, cleared for takeoff*"). Once N252MN has departed and is clear of any local traffic, the local controller advises the pilot to contact departure control ("*N252MN, contact departure*").

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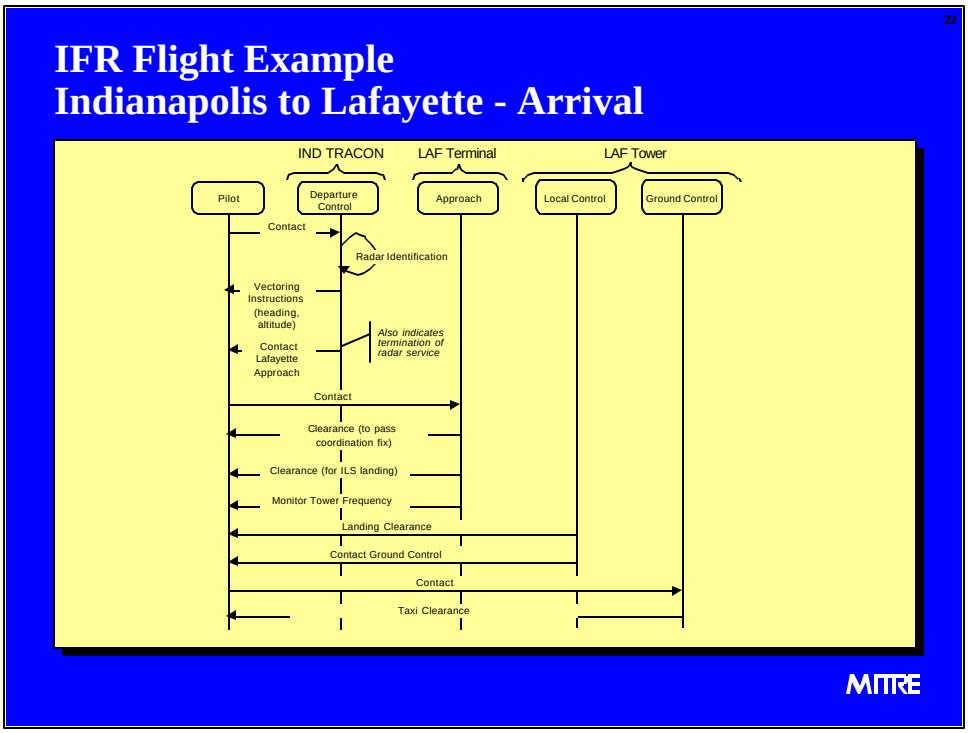

Departure Control Indianapolis TRACON has divided departure separation responsibility among four departure controllers. Each controller is responsible for approximately one quarter of the airspace delegated to Indianapolis tower. The departure controller responsible for separating N252MN (the north departure controller) must radar identify N252MN and confirm that the mode C readout is accurate. Then, traffic permitting, N252MN is cleared to join the airway and climb to the final cruising altitude. Since the pilots of N252MN were cleared to Lafayette via victor 97, the departure controller must vector the aircraft to join that airway ("*N252MN, Indianapolis departure, radar contact, fly heading three six zero, join victor ninety-seven, climb and maintain four thousand. Verify leaving one thousand two hundred*"). When the departure controller has resolved any potential traffic conflicts, and before the aircraft crosses the Indianapolis/Lafayette boundary, the departure controller advises the pilots of N252MN that their radar service is being terminated and that they should contact Lafayette approach control. This transfer of communication normally occurs somewhere near the Leban intersection (*"N252MN, radar service terminated three miles southeast of the Leban intersection, contact Lafayette approach on one two three point eight five"*).

Lafayette Approach Control Upon initial contact with the Lafayette approach controller, N252MN is advised which approach to expect at Lafayette and is then cleared past Ockel or cleared to enter a holding pattern at Ockel. If N252MN must enter a holding pattern, the Lafayette controller must inform Indianapolis approach, since the Ockel holding pattern overlaps Indianapolis's airspace. But in most cases, N252MN will be cleared past Ockel to the Earle outer marker on the ILS runway 10 approach into Lafayette (*"N252MN is now cleared to the Earle outer compass locator via Ockel direct. Hold west of Earle on the localizer. Maintain four thousand. Expect further clearance at one six one zero. Time now one five five three"*). Whenever traffic permits, N252MN will be cleared for the ILS approach. If more than one aircraft is inbound to Lafayette, however, each aircraft will normally be held at the outer marker or at one of the fixes on the airways inbound to Lafayette. The aircraft holding at the outer marker will be "stacked" vertically, using 1,000-foot separation, and will be cleared for the approach one at a time. As the bottom aircraft in the stack is cleared for the approach, every other aircraft in the stack will be descended 1,000 feet, while a new aircraft brought over from an outer fix to the top of the stack. Once N252MN is next in line for the ILS approach, the approach controller at Lafayette verbally advises the local controller of N252MN's position and the type of approach being conducted. The aircraft can then be cleared for the approach (*"N252MN cleared for the ILS runway one zero approach. Monitor tower one one niner point six, report Earle inbound"*).

Lafayette Tower Once the aircraft crosses the outer marker; it is the local controller's responsibility to sequence N252MN into the inbound flow of traffic (*"N252MN cleared to land runway one zero. Traffic is a Piper Cherokee on short final runway two three"*). When N252MN has landed, the pilots contact the ground controller; who will issue a clearance to taxi to the parking ramp.

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Issues

- Impact of ICAO flight plans to flight data distribution and coordination
- Impact of Mode-S transponders on beacon code assignments
- Definition of FDP/RDP functionality delineation
- Whether metering should be considered an FDP function
- Use of flight strips
- Impact of shifting some FDP functions to terminal systems

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