



# Initial Trajectory-Based Operations

## Decision Making and Data Flow

Trajectory-Based Operations (TBO) is an air traffic management (ATM) concept that enhances strategic planning of aircraft flows to reduce capacity-to-demand imbalances in the National Airspace System (NAS), and provides tools to air traffic management personnel and controllers to help expedite aircraft movement between origin and destination airports.

Through improved strategic planning and management of traffic flows, TBO helps reduce reactive decision-making and use of static miles-in-trail restrictions.

TBO builds on the FAA's investments in time-based management tools, and on the FAA's and Flight Operators' investments in advanced navigation capabilities.

Initial TBO (iTBO) delivers key TBO capabilities at a limited, initial set of locations, concluding with operational availability of time-based management across domains. TBO continues to evolve through continued expansion of iTBO capabilities and introduction of new capabilities as possible and needed, and further integration across domains and automation platforms.

# User Guide

This interactive PDF mirrors decision-making and data-flow of an ongoing progression of strategic and tactical traffic management – planning, execution and completion of operations throughout the NAS.

It depicts the interactions between people and systems as executed today (***Current Nominal***), and as will be executed with new capabilities that will become operational at the end of iTBO timeframe (***Future Nominal***).

You can navigate through the PDF one page at the time, or by clicking at phase of flight, events in a given phase, and applicable people or systems.

[Infographic Guide »](#)



[Planning »](#)



[Pre-Departure »](#)



[Departure »](#)



[En Route »](#)



[Arrival »](#)

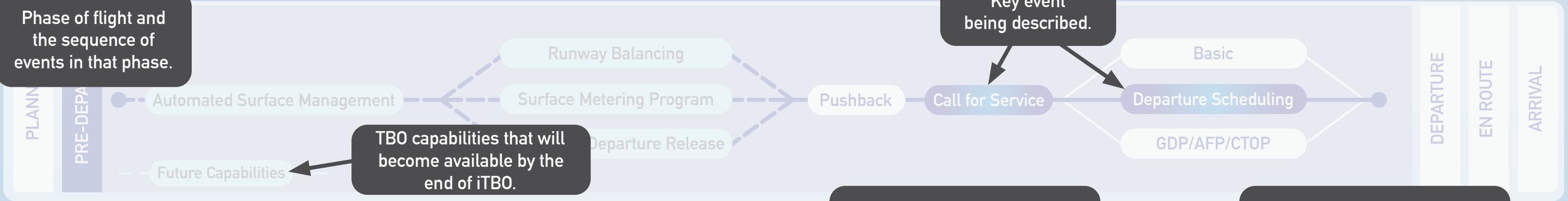
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[Glossary »](#)

# Pre-Departure

Pre-departure flight preparation activities take place between the time the flight plan is filed and the flight enters the non-movement area on the airport surface.

Phase of flight and the sequence of events in that phase.



Departure scheduling helps with management of take-off times for aircraft that are expected to join constrained traffic flows along their filed route. This facilitates smooth merging of departures with aircraft that are already airborne, and smooth merging of aircraft through common fixes along the route.

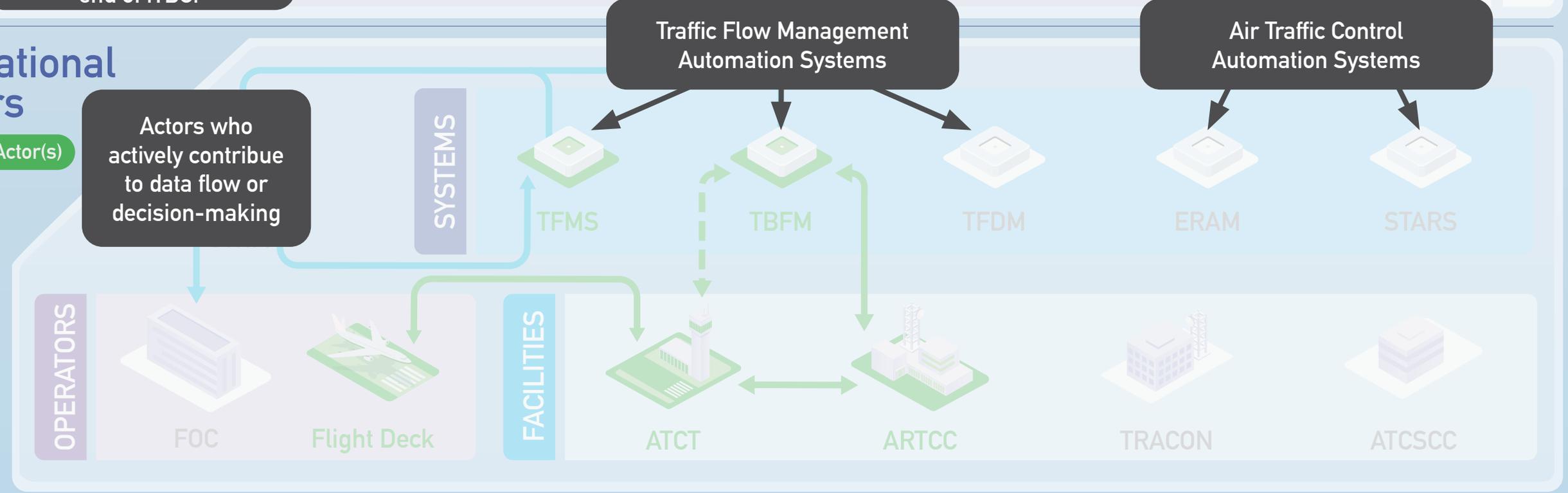
General description of the phase, key actions and decisions made in the current or future NAS.

## Operational Actors

Current Actor(s)

Actors who actively contribute to data flow or decision-making

1/1



### INPUTS:

Flight Deck requests...  
 ATCT TMC requests...  
 ARTCC TMC enters...  
 If ATCT is using IBAO, they can obtain the departure release time directly from TBFM.

Inputs into automation systems or Actions by key actors associated with each key event by phase of flight.

### OUTPUTS:

Aircraft is scheduled...  
 ATCT provides...  
 TBFM shares flight...  
 TFMS updates... as needed.

Outputs from automation systems or Outcomes and decisions by key actors associated with each key event by phase of flight.



# Planning

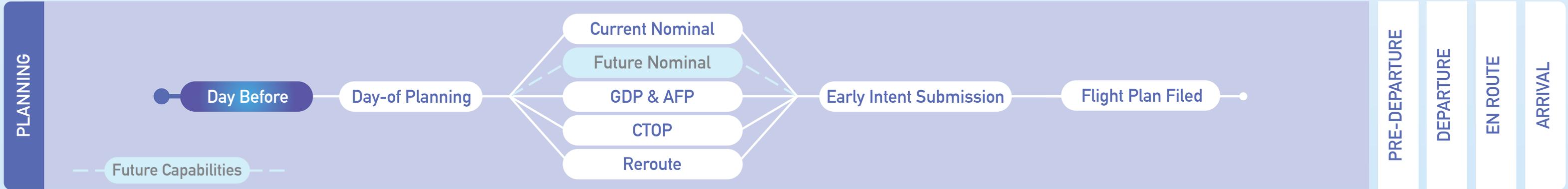
Strategic Planning is a continuous process and includes on-going information exchange between the FAA and Flight Operators.

## PLANNED OPERATIONAL IMPROVEMENTS:

- Continuous planning process which begins before the day of operation and continues throughout the day
- Enhanced information sharing between FAA and Flight Operators
- Expanded use of TBM
  - TBM is the nominal operation in the NAS
  - Conventional TMIs complement TBM as needed
- Improved demand predictions and strategic planning through
  - Integration of TFDI, TFMS and TBFM
  - Increased use of operator data
- Increased flexibility for the Flight Operators using CTOP and TOS

## CHALLENGES:

- Flight-specific impacts are difficult to predict before the Day-of operation
- Without integration of decision support systems, use of early intent data is limited to TFMS
- TBFM learns about a new departure when the flight plan is received, but the flight is not scheduled into applicable timelines until the Call-for-Service is made, potentially leading to
  - Large, unexpected departure delays for short flights, and
  - The need to apply ground delays incrementally by first strategic (e.g. GDP) and then tactical (e.g. departure scheduling) actions.



Strategic Planning begins before the Day-of operation, and sets the stage for traffic management based on expected demand and operating conditions in the NAS for that day. Early planning helps to mitigate known constraints and allocate resources for the Day-of operation.

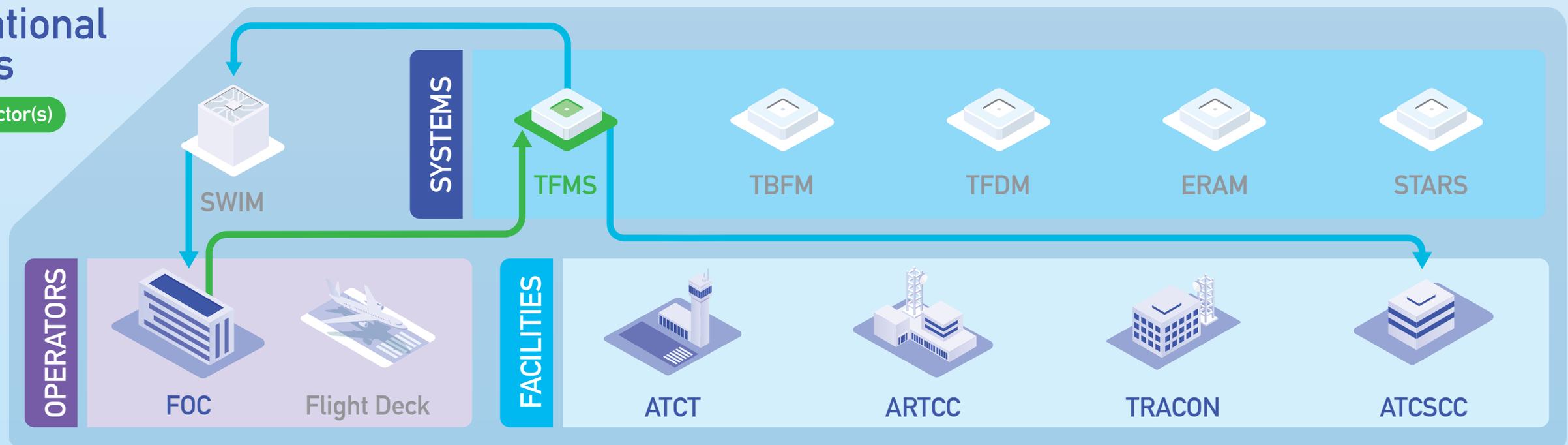
The ATCSCC develops an Advanced Plan for the Day-of operation based on forecasts, known constraints, and feedback from Flight Operators and field facilities. The plan includes expected use of TBM and conventional TMIs as needed to conduct safe and efficient operations throughout the NAS.

The Advanced Plan helps facilities and Flight Operators prepare for the Day-of operation. It does not address flight specific impacts.

## Operational Actors

Current Actor(s)

Step 1/3

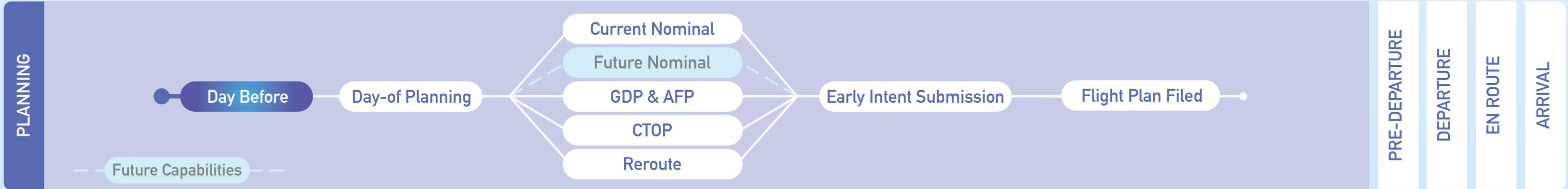


● INPUTS: →

OAG Schedules and updates from NAS Users (FOC)

● OUTPUTS: →

Aggregated and updated demand (to TFMS users)



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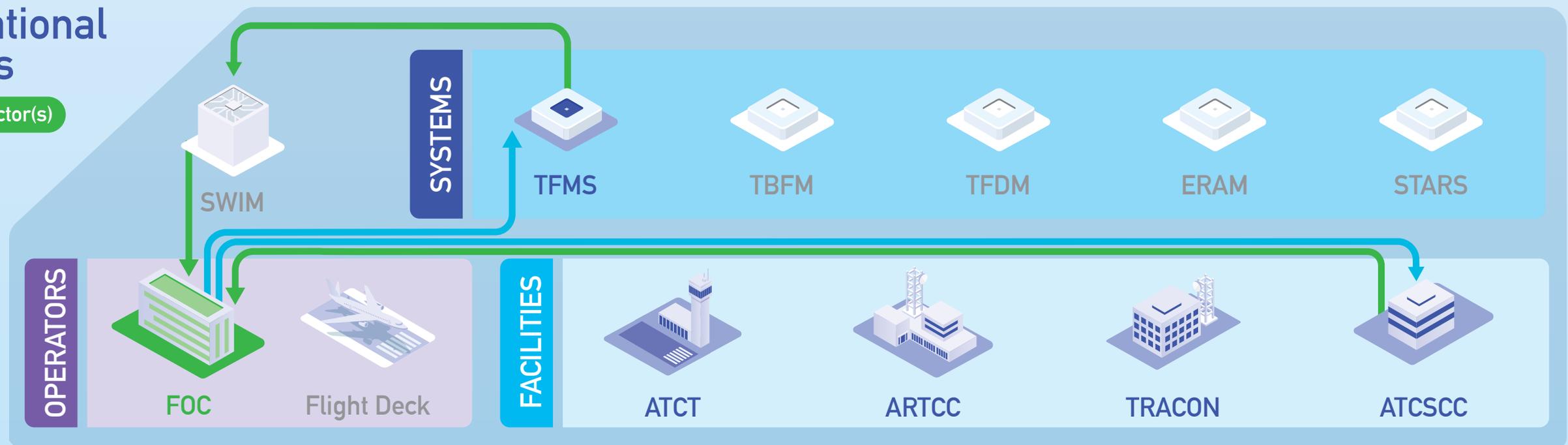
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## Operational Actors

Current Actor(s)

Step 2/3

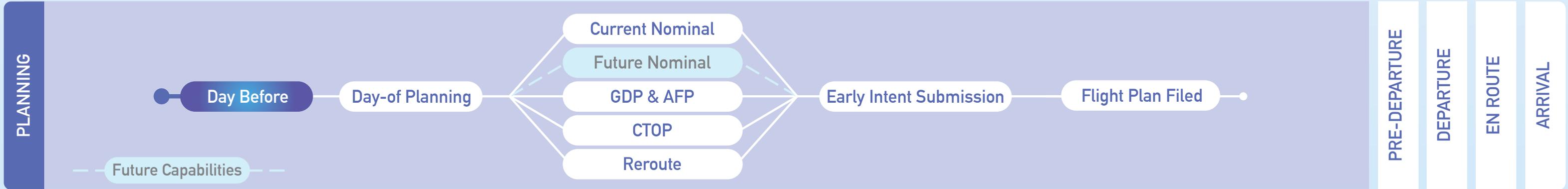


● **ACTIONS:** →

FOCs complement their own weather forecasts and flight schedules with the information from the Advanced Plan and the planning website.

● **OUTCOMES:** →

Updated flight schedules to TFMS  
Feedback to ATCSCC for the Advanced Plan



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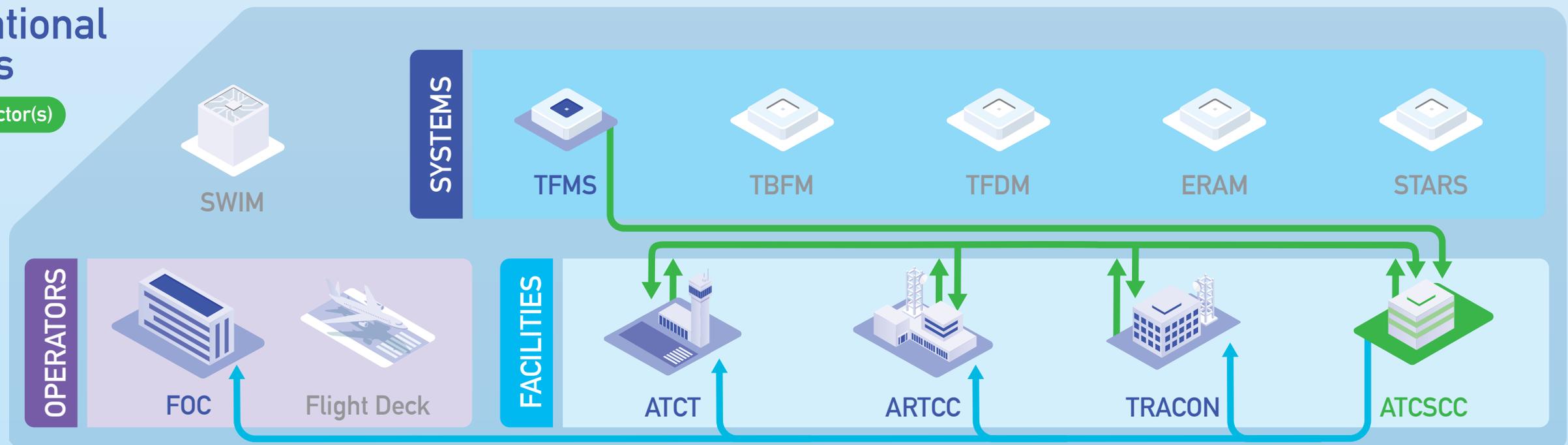
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## Operational Actors

Current Actor(s)

Step 3/3



**ACTIONS:** →

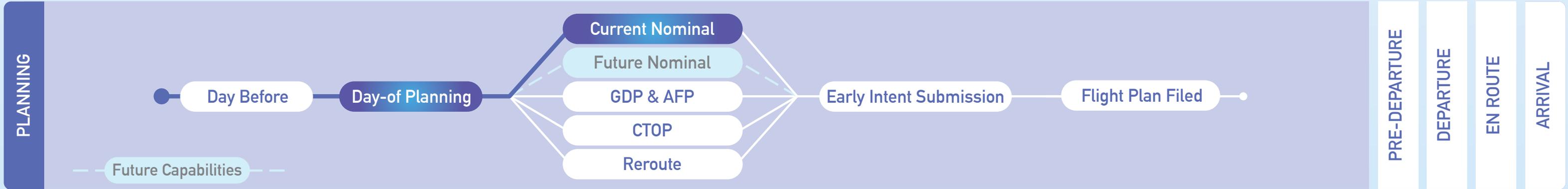
The ATCSCC develops the Advanced Plan using weather forecasts, scheduled events and TFMS demand.

The Plan is reviewed and updated with stakeholders at the 1430 Advanced Planning Webinar, including feedback on expected operational impacts and TMI use.

TMCs collaborate to plan the next day's operation, and provide inputs to the ATCSCC.

**OUTCOMES:** →

The Advanced Plan is created and posted on the planning website.



On the Day-of operation the ATCSCC builds on the Advanced Plan to create the Day-of Operational Plan (Ops Plan).

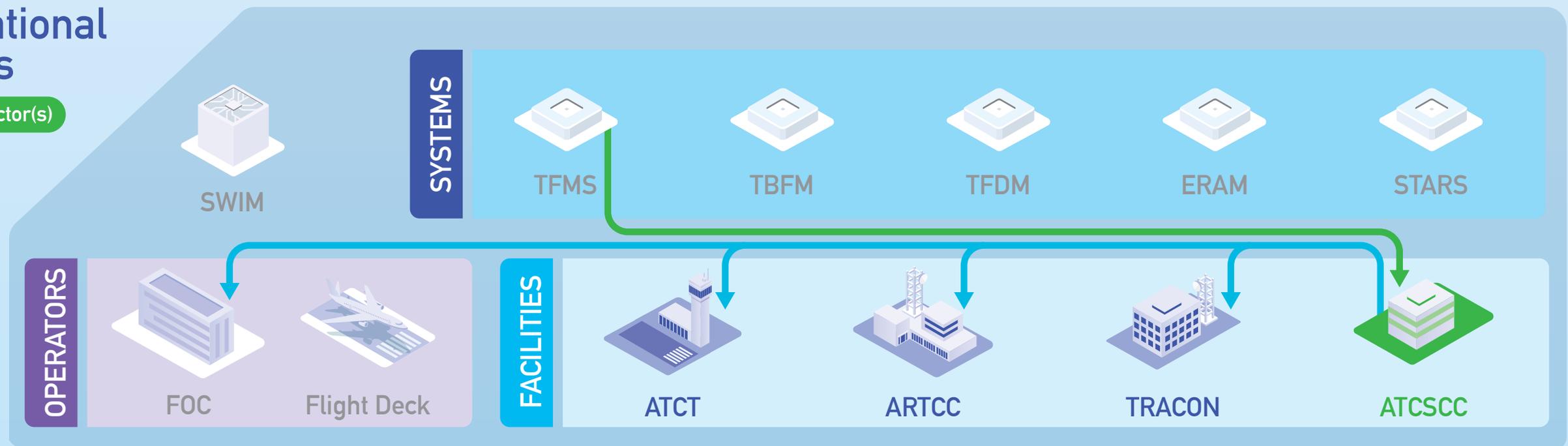
Prior to receiving Flight Operators' provided intent data or flight plans, TFMS demand predictions are based on published OAG schedules and historical route data. As the flight information is dynamically updated throughout the day, TFMS revises estimated departure and arrival time based on the best available data.

Throughout the day the Ops Plan is continuously updated in response to dynamically changing operating conditions.

## Operational Actors

Current Actor(s)

Step 1/2

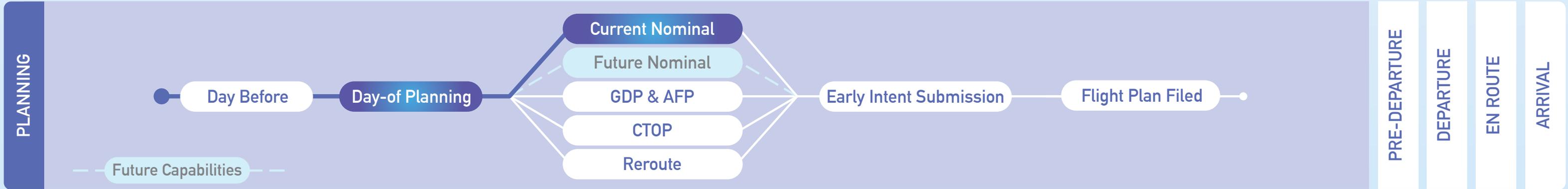


**ACTIONS:** →

ATCSCC generates the Ops Plan and advisories in NTML based on the FAA's weather forecast, TFMS demand predictions, and emerging constraints. ATCSCC monitors and approves TMLs that may be requested by facilities to address local constraints.

**OUTCOMES:** →

ATCSCC establishes Ops Plan, and shares it with stakeholders along with traffic management advisories. Updates are coordinated with stakeholders via planning website and live webinars every two hours throughout the day.



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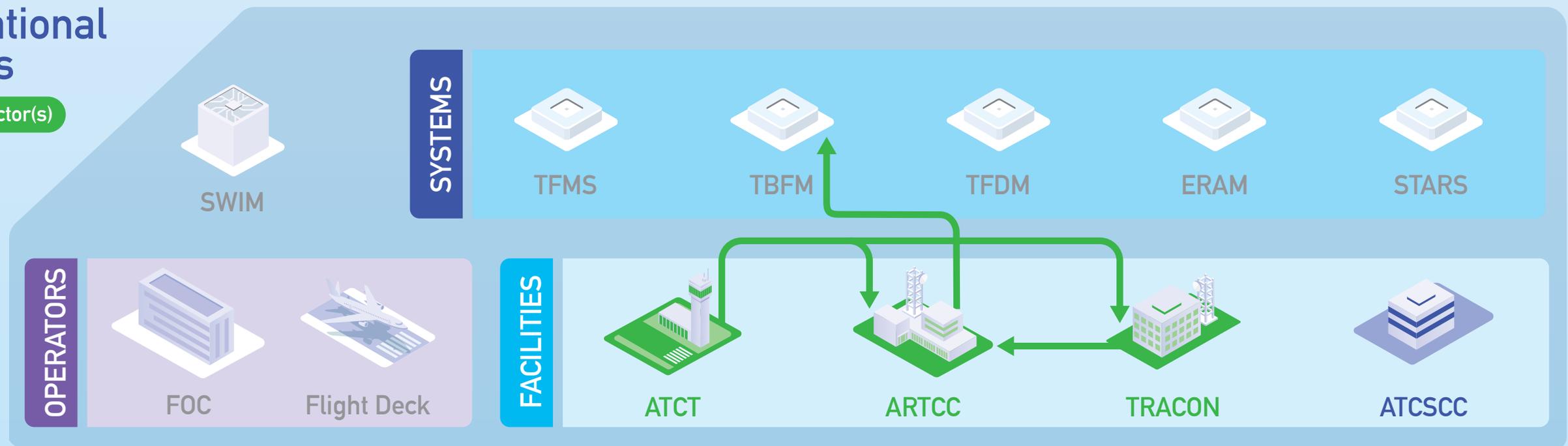
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## Operational Actors

Current Actor(s)

Step 2/2



**ACTIONS:** →

ARTCC, TRACON and ATCT TMCs actively participate in planning webinars, collaborate on use of TBM and MIT restrictions, and manage NTML records for use of TBM and MIT as needed.

For IDAC, ARTCC TMC activates departure scheduling time frames and types (XM, Arrival, EDC) by destination (in TBFM).

For Airborne Metering, ARTCC TMC enters appropriate parameters for airport configuration, runway separation matrix, desired separation at meter fix and XM arcs. TM begins broadcasting metering information to en route controllers when airborne metering is activated.

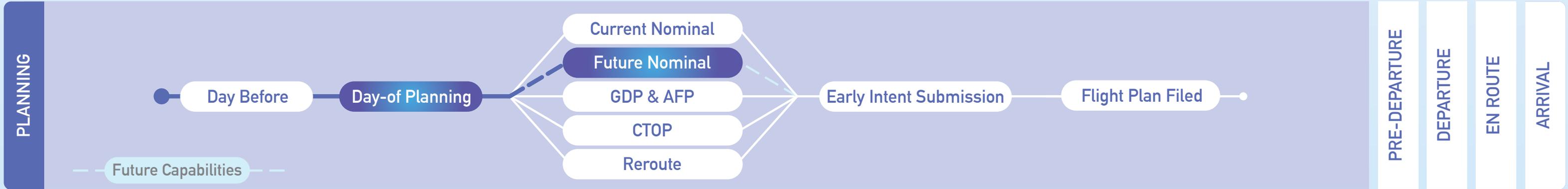
For EDC, ARTCC TMC enters desired spacing (MIT) for aircraft when reaching constraint point (meter arc) in TBFM.

**OUTCOMES:** →

NTML Update on Active Use of departure scheduling, airborne metering, and MIT.

Local traffic management advisories as needed.

Relevant operational status updates as needed.



The ATCSCC continuously updates the Ops Plan in response to dynamically changing operating conditions throughout the day.

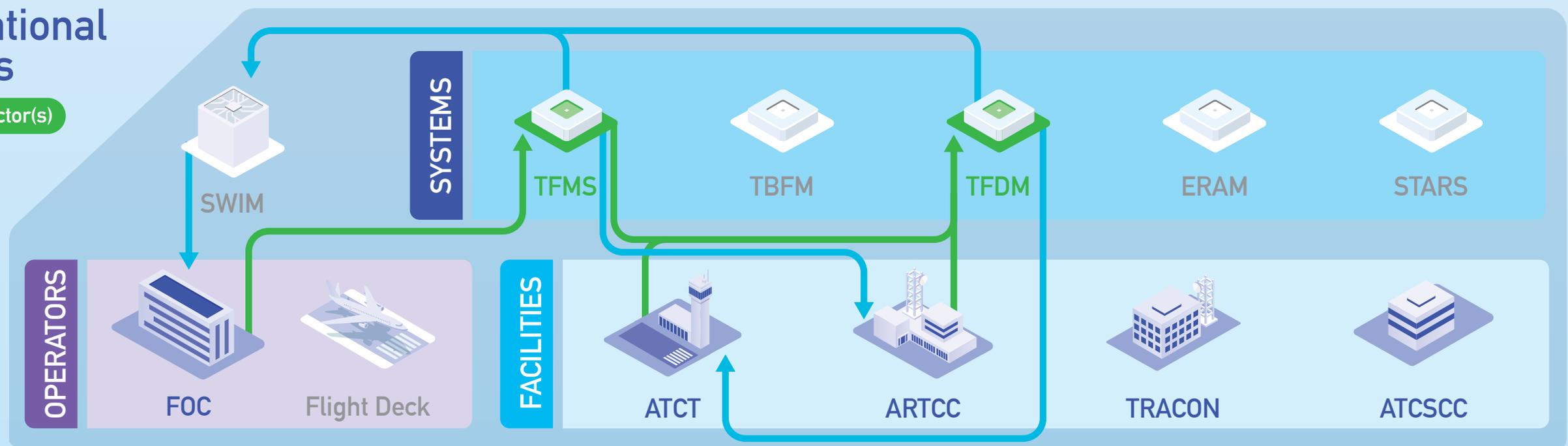
TFDM will bring automation to surface management including electronic flight strips, surface scheduling and metering, runway load balancing, and integration with other decision support systems and external stakeholders.

TFMS continues to help manage evolving operational constraints throughout the NAS at a larger scale, and TBFM to help develop schedules for aircraft sequences through adapted resources (fixes, runways, center boundaries, etc). TFDM facilitates communication between TFMS and TBFM.

## Operational Actors

Current Actor(s)

Step 1/2

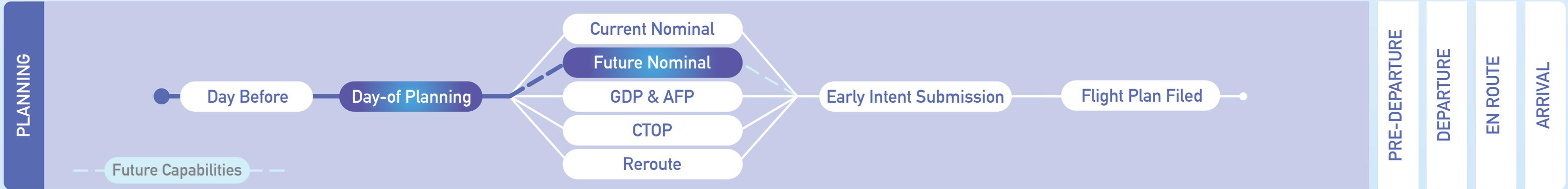


**INPUTS:** →

- Flight Data
- Flight-specific unacceptable runways
- Airport configuration
- Active TMs
- Recommendations for SMP parameters

**OUTPUTS:** →

- TFDM generated SMP recommendations
- Surface schedule and runway assignments
- Candidate aircraft for moving to alternate runways
- Updated ETDs, as needed



The ATCSCC continuously updates the Ops Plan in response to dynamically changing operating conditions throughout the day.

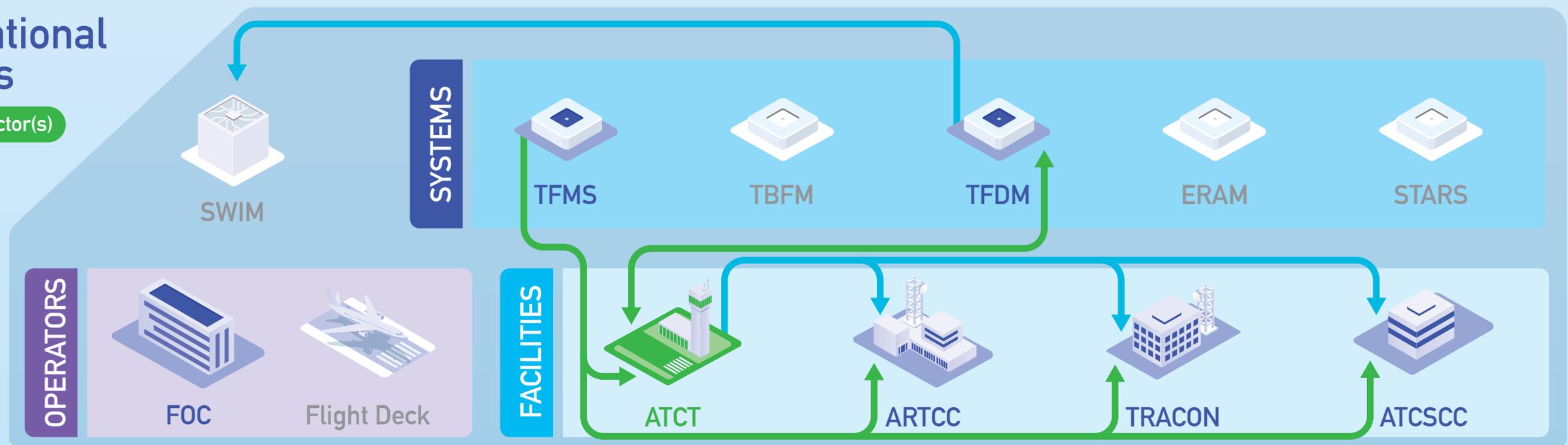
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## Operational Actors

Current Actor(s)

Step 2/2

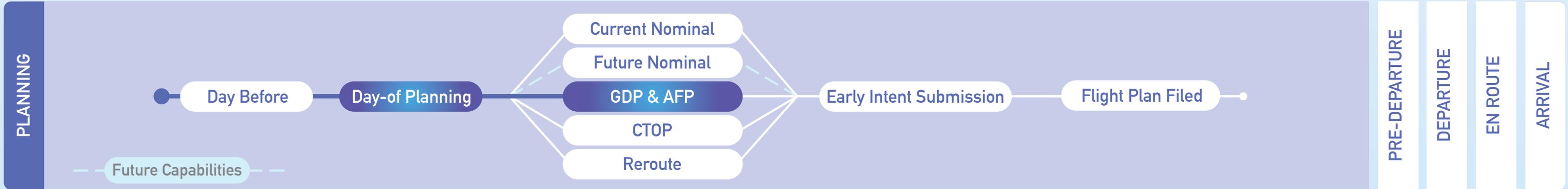


**ACTIONS:** →

ATCT TMC reviews SMP recommendation parameter and data from TFDM, coordinates with other facilities and local stakeholders as needed, and may activate SMP.

**OUTCOMES:** →

ATCT TMC manually enters SMP information in NTML  
 TFDM automatically publishes SMP information via SWIM  
 TMCs across facilities monitor surface movement and demand (via TFMS Surface Viewer), and continue coordination as needed



The ATCSCC continuously updates the Ops Plan in response to dynamically changing operating conditions throughout the day.

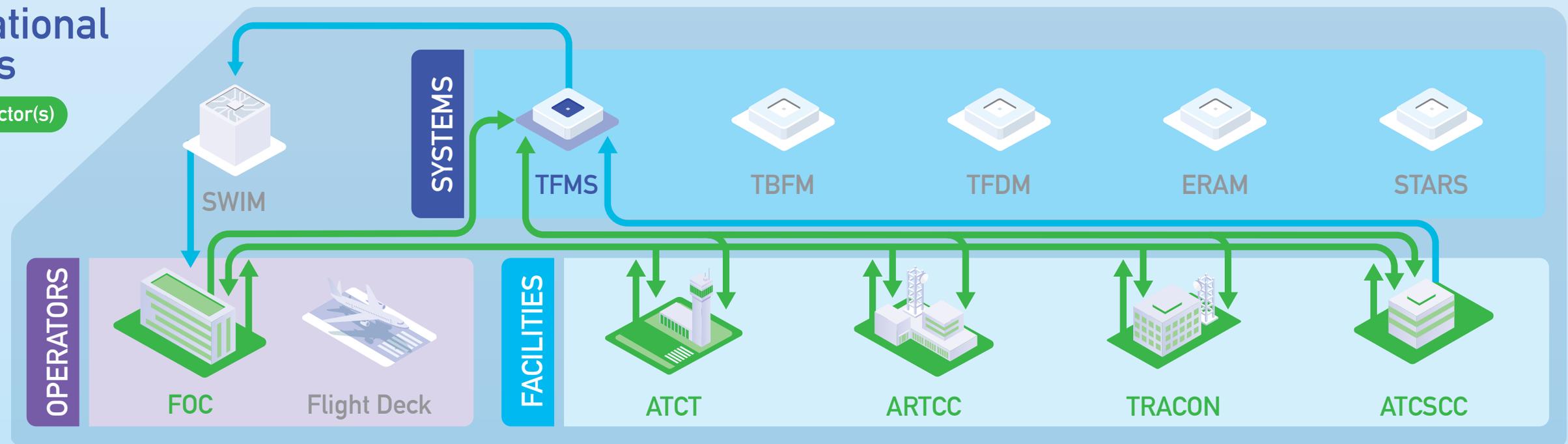
Strategic TMI help manage traffic flows during sustained periods of demand/capacity imbalance. Expanded availability and use of TBM across domains and the NAS will lead to a reduction in strategic TMI use.

GDPs and AFPs assign arrival slots and ground delays to departures to smooth the demand at their destinations (GDP) or through a specific airspace on their route (AFP). These TMIs offer Flight Operators predictability because ground delays are typically known several hours in advance, and flexibility because flight-specific arrival slots can be substituted as needed to manage their business priorities.

## Operational Actors

Current Actor(s)

Step 1/2

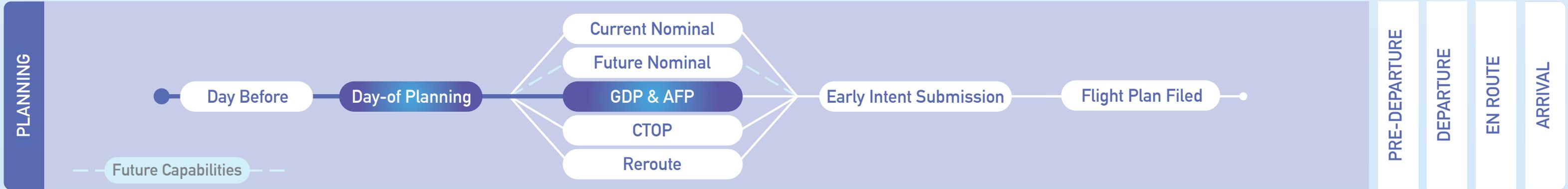


**ACTIONS:** →

ATCSCC coordinates GDP and AFP parameters and scope with other facilities and stakeholders.

**OUTCOMES:** →

ATCSCC updates TMIs/Advisories as needed, including expected and active use of GDP and AFP.



The ATCSCC continuously updates the Ops Plan in response to dynamically changing operating conditions throughout the day.

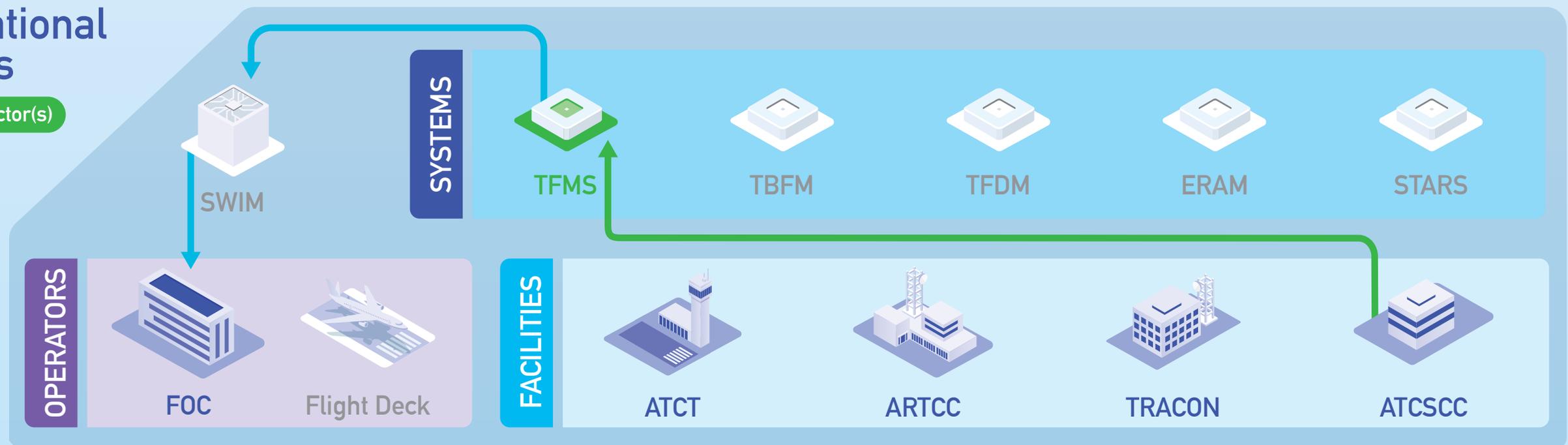
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## Operational Actors

Current Actor(s)

Step 2/2



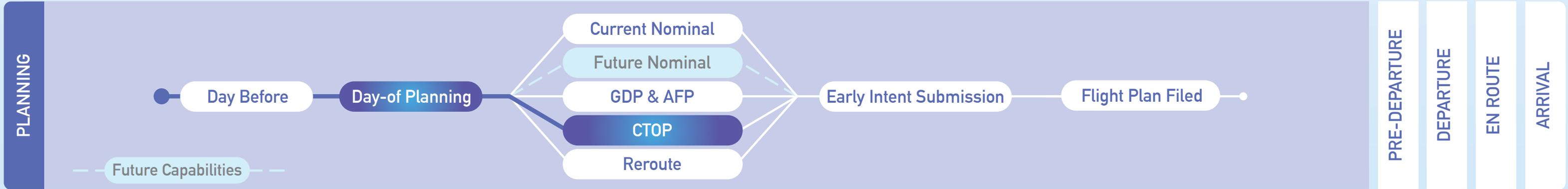
● **INPUTS:** →

Flight Data

ATCSCC inputs GDP and AFP parameters and scope into TFMS

● **OUTPUTS:** →

TFMS updates demand predictions, estimates flight-specific EDCTs, and shares relevant information with Flight Operators via SWIM



The ATCSCC continuously updates the Ops Plan in response to dynamically changing operating conditions throughout the day.

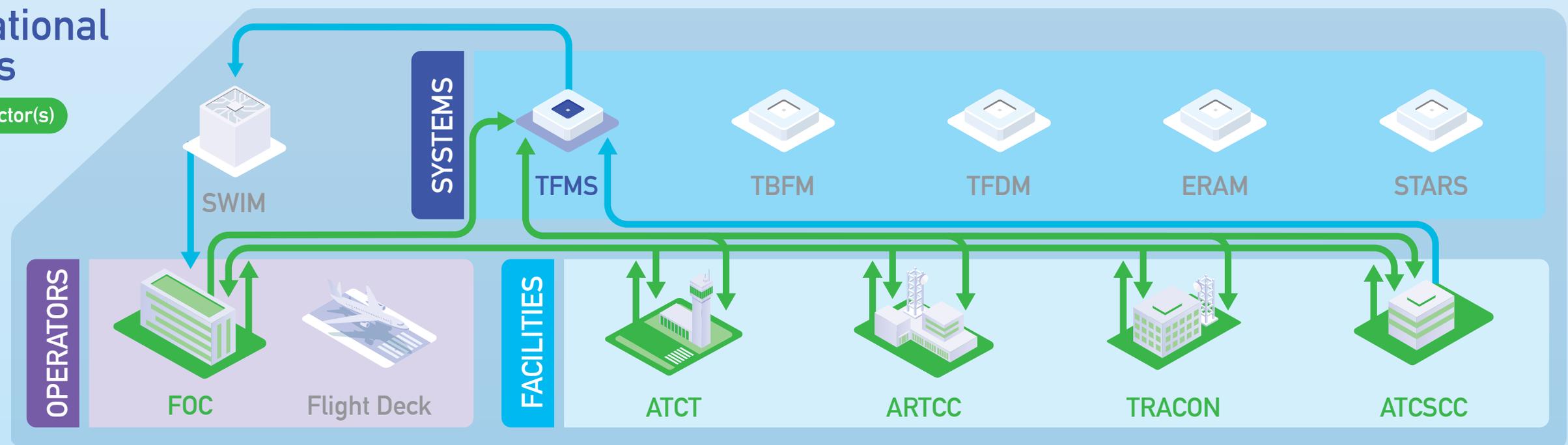
Strategic TMIs help manage traffic flows during sustained periods of demand/capacity imbalance. Expanded availability and use of TBM across domains and the NAS will lead to a reduction in strategic TMI use.

CTOP helps manage sustained capacity/demand imbalances within multiple Flow Constraint Areas (FCAs) with a single program. It also provides Flight Operators additional flexibility by considering their prioritized preferences for routing and ground delays as submitted in their Trajectory Option Set (TOS).

## Operational Actors

Current Actor(s)

Step 1/2

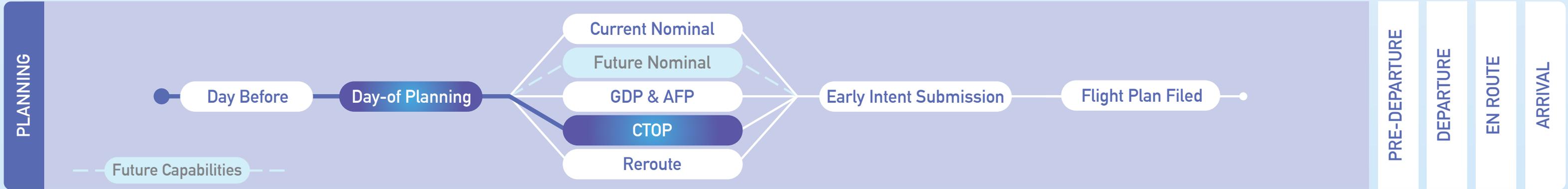


● **ACTIONS:** →

ATCSCC coordinates CTOP/FCA parameters and scope with other facilities and stakeholders.

● **OUTCOMES:** →

ATCSCC updates TMIs/Advisories as needed, including expected and active use of CTOP/FCAs.



The ATCSCC continuously updates the Ops Plan in response to dynamically changing operating conditions throughout the day.

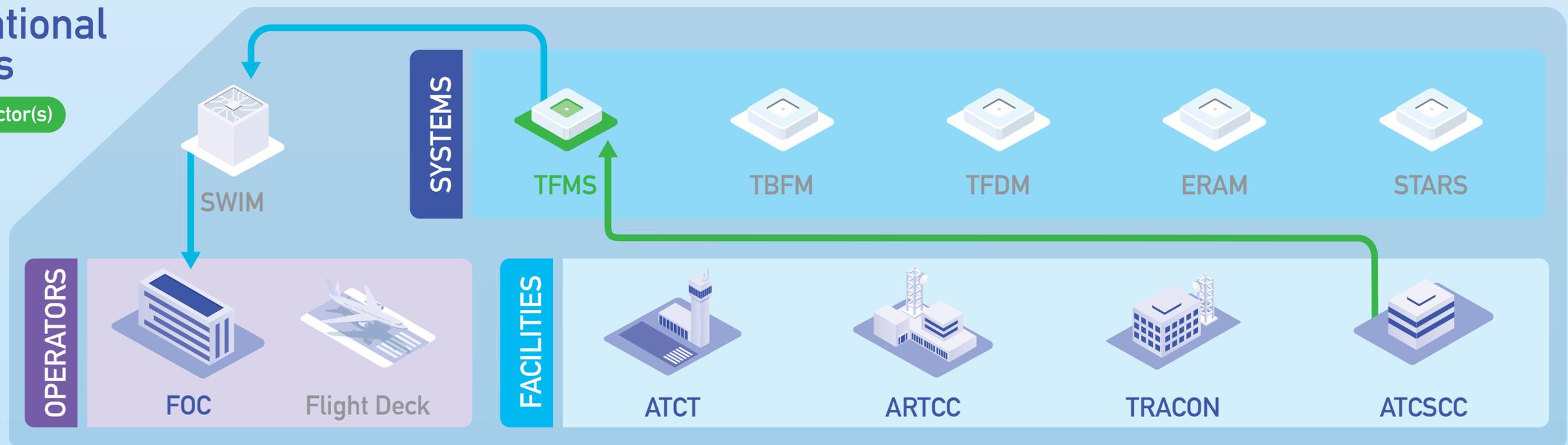
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Current Actor(s)

Step 2/2

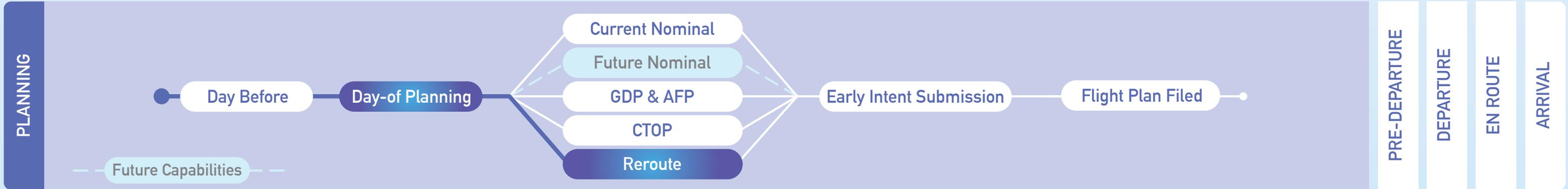


**ACTIONS:** →

- Flight Data, including TOS
- ATCSCC inputs CTOP/FCA parameters and scope into TFMS

**OUTCOMES:** →

TFMS updates demand predictions, estimates flight-specific EDCTs, and shares relevant information with Flight Operators via SWIM



The ATCSCC continuously updates the Ops Plan in response to dynamically changing operating conditions throughout the day.

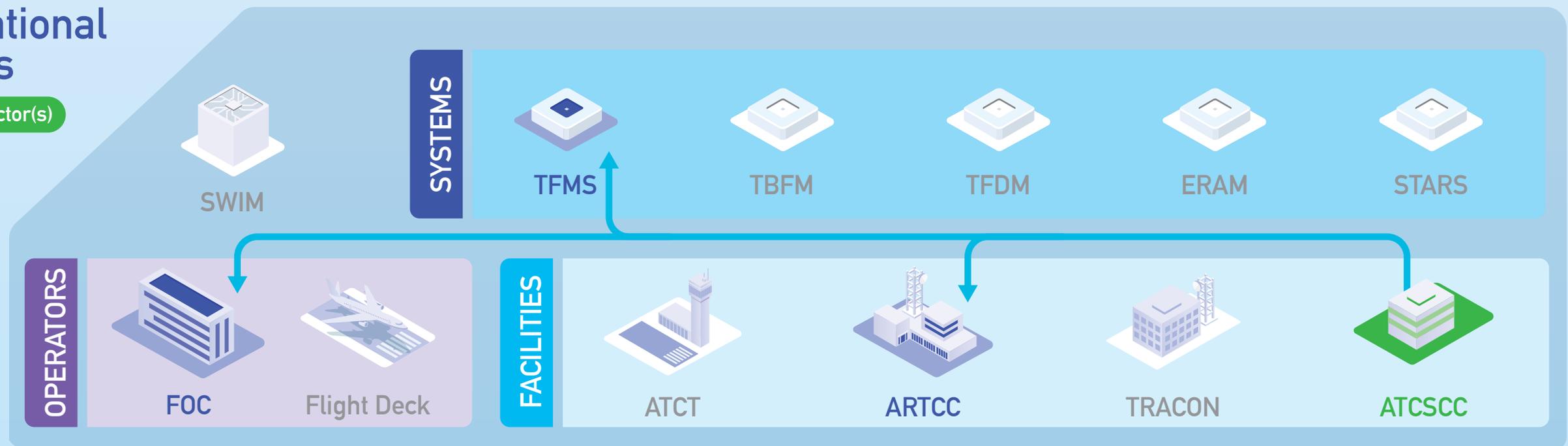
Strategic TMI's help manage traffic flows during sustained periods of demand/capacity imbalance. Expanded availability and use of TBM across domains and the NAS will lead to a reduction in strategic TMI use.

When weather forecasts or other conditions indicate that aircraft will need to avoid specific airspace, the ATCSCC will issue reroute advisories, including possible, probable, and required routes. During an active Required Reroute advisory, Flight Operators must submit filed flight plans consistent with the specified routes; otherwise, ARTCC traffic managers will need to make adjustments to the non-complying flight plans. ARTCC traffic managers use Reroute Impact Assessment (RRIA), Reroute Monitor, and other TFMS tools to manage and monitor aircraft rerouting.

## Operational Actors

Current Actor(s)

Step 1/2

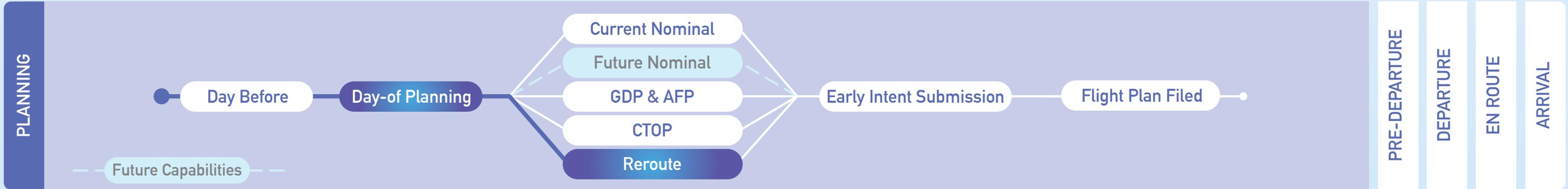


**ACTIONS:** →

Planner provides TMI's/Advisories as necessary including possible/probable/required routes.

**OUTCOMES:** →

Updates to planning website as needed throughout the day.



The ATCSCC continuously updates the Ops Plan in response to dynamically changing operating conditions throughout the day.

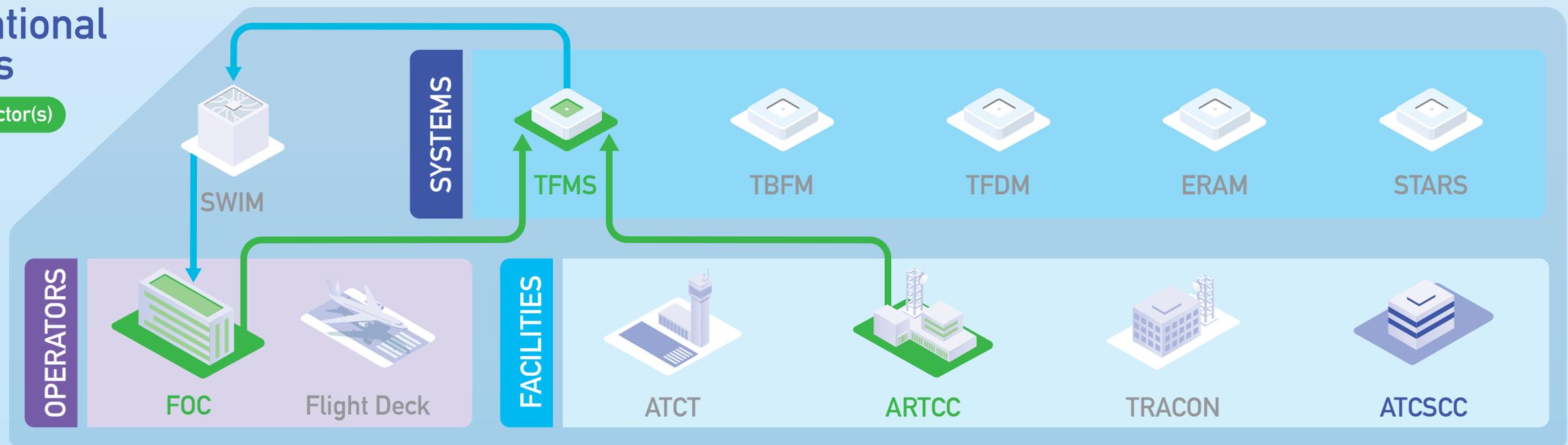
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## Operational Actors

Current Actor(s)

Step 2/2

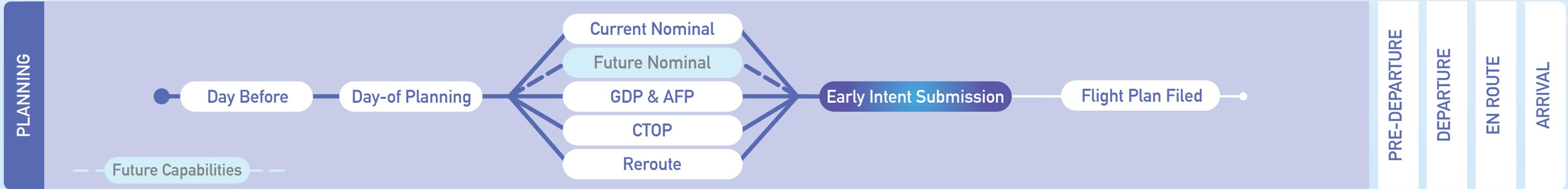


**ACTIONS:** →

Flight amendments with updated routing information

**OUTCOMES:** →

TFMS updates demand predictions, and shares relevant information with Flight Operators via SWIM



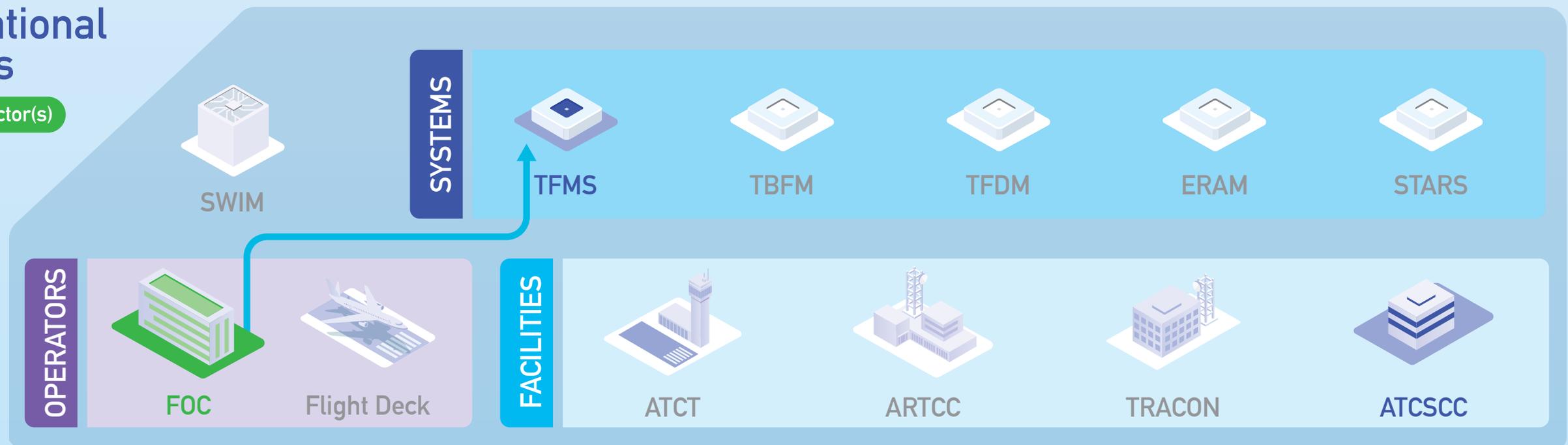
Together with TBM decision support systems, accurate and timely data from Flight Operators help generate more feasible time-based schedules and achieve greater adherence to the schedules. Together, they deliver improved predictability of aircraft movement on the Day-of-operation.

Early intent data is used to update TFMS demand predictions, and includes intended routes, earliest off block time (EOBTs), and other relevant flight specific inputs.

## Operational Actors

Current Actor(s)

Step 1/3

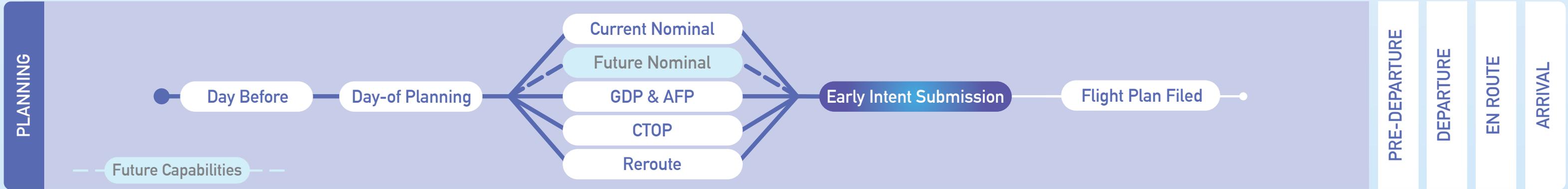


**ACTIONS:** →

FOC automation sends flight-specific early intent data to TFMS via CDMNet per CDM MOA.

**OUTCOMES:** →

Early Intent and other flight specific data such as EOBT, tail number, gate assignment, ERTD (to TFMS)



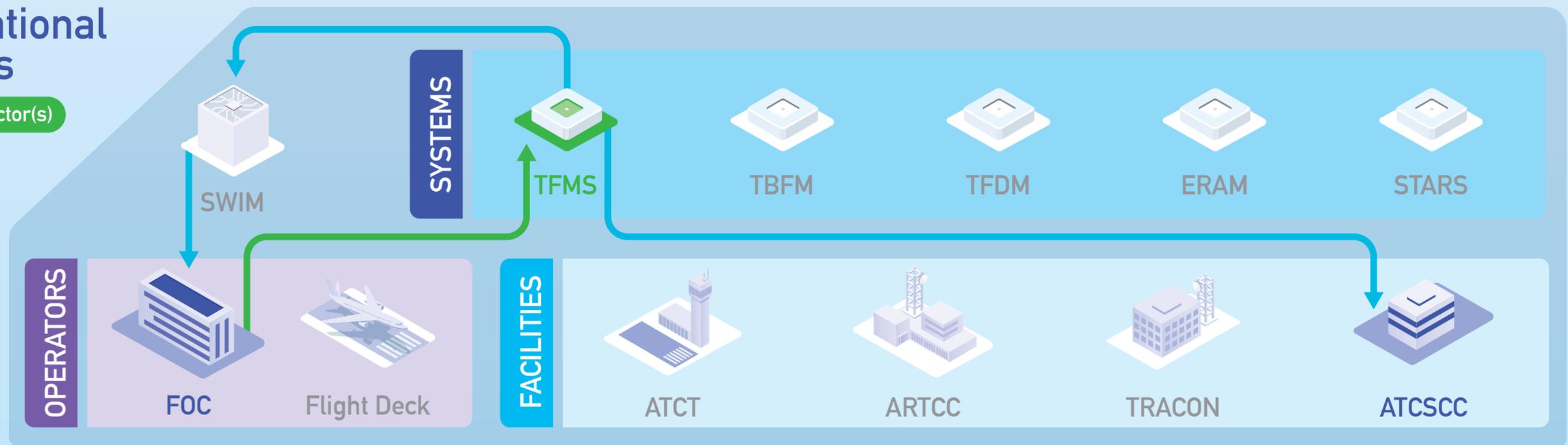
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## Operational Actors

Current Actor(s)

Step 2/3

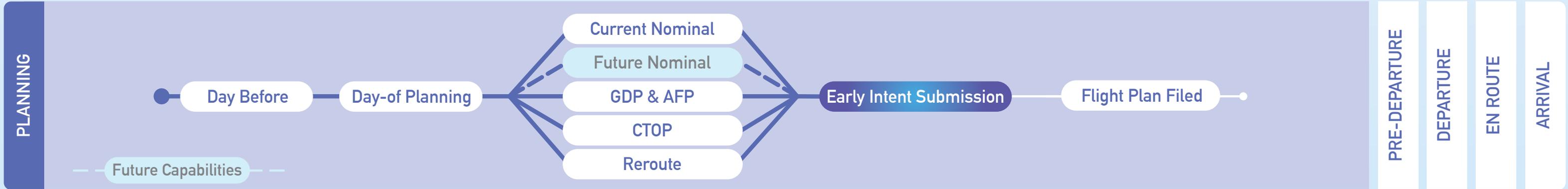


● **INPUTS:** →

Early Intent and other flight specific data such as EOBT, tail number, gate assignment, ERTD (from FOCs)

● **OUTPUTS:** →

Updated ETD, ETA, and tools/displays as needed (to TFMS users).



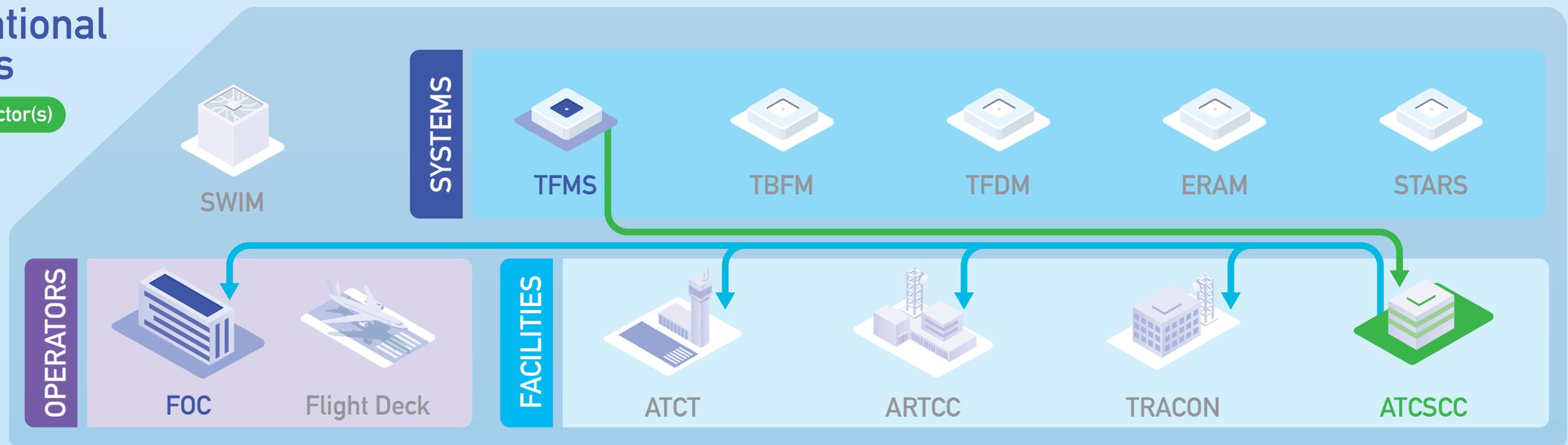
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## Operational Actors

Current Actor(s)

Step 3/3

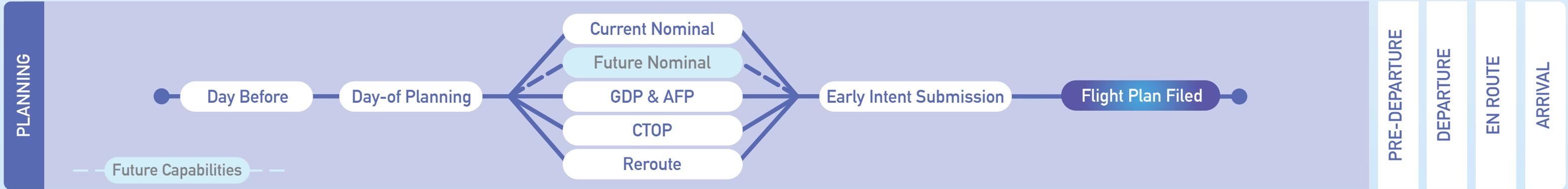


● **ACTIONS:** →

ATCSCC updates Ops Plan based on updated weather and TFMS' demand information.

● **OUTCOMES:** →

Updates Day-Of Ops Plan as needed.



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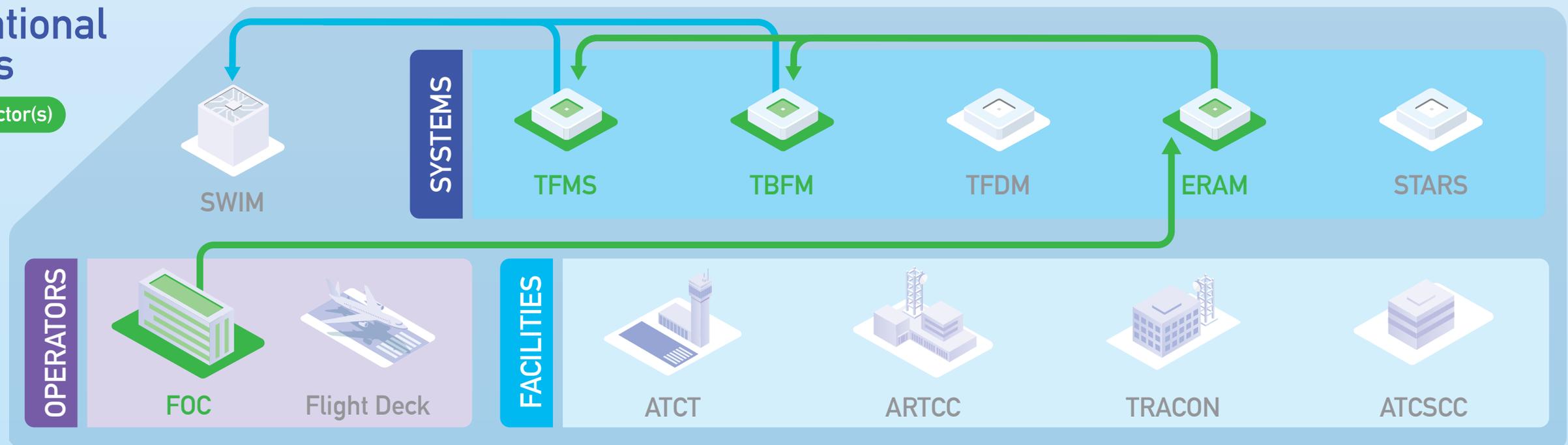
The earliest ERAM can currently accept flight plans is 2 hours prior to departure. ERAM shares the flight plan information with TFMS and TBFM, which then update their own internal trajectory predictions.

TBFM first becomes aware of the flight when it receives its flight plan from ERAM.

## Operational Actors

Current Actor(s)

Step 1/1



**INPUTS:** →

- Flight Plans (to ERAM from FOC)
- Flight Plans (to TFMS and TBFM from ERAM)

**OUTPUTS:** →

- TFMS ETD, ETA, and updated tools/displays
- TBFM displays aircraft on the Departure Timeline



# Pre-Departure

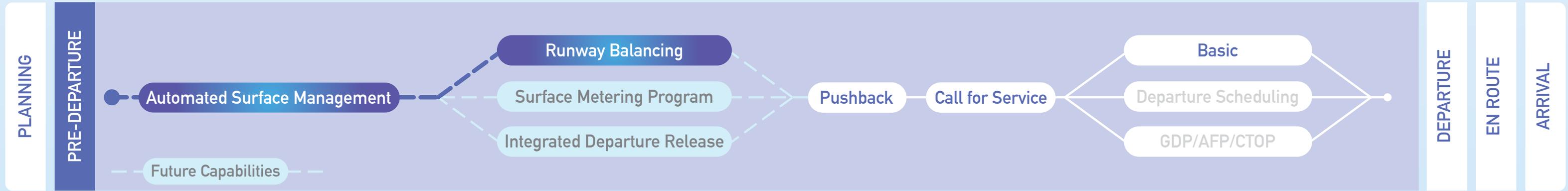
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## PLANNED OPERATIONAL IMPROVEMENTS:

- Smoother and more efficient merging of departures with airborne traffic with Departure Scheduling
- More efficient scheduling of departure release times with IDAC's electronic communications between ATCT and ARTCC
- Improved departure release management
  - Integration of TFDM, TFMS and TBFM
  - Increased use of operator data
- More efficient surface operations through TFDM-enabled Automated Surface Management tools including electronic flight strips, runway load balancing and Surface Metering Program (SMP)

## CHALLENGES:

- Without IDAC, ATCT does not have insight into the overhead stream and available slots, and coordinates release times via phone call.
- Without integrated decision support tools, use of early intent data is limited to TFMS
- Even after integration of traffic flow management decision support systems, there will occasionally be a need to apply departure delays incrementally:
  - Strategic delays by TFMS, and
  - Tactical delays by TBFM.
- Without TFDM, ATCT has limited decision support tools to help them comply to scheduled departure release times
- Dynamically changing conditions in the NAS will continue to cause uncertainty in advanced information about departure delays



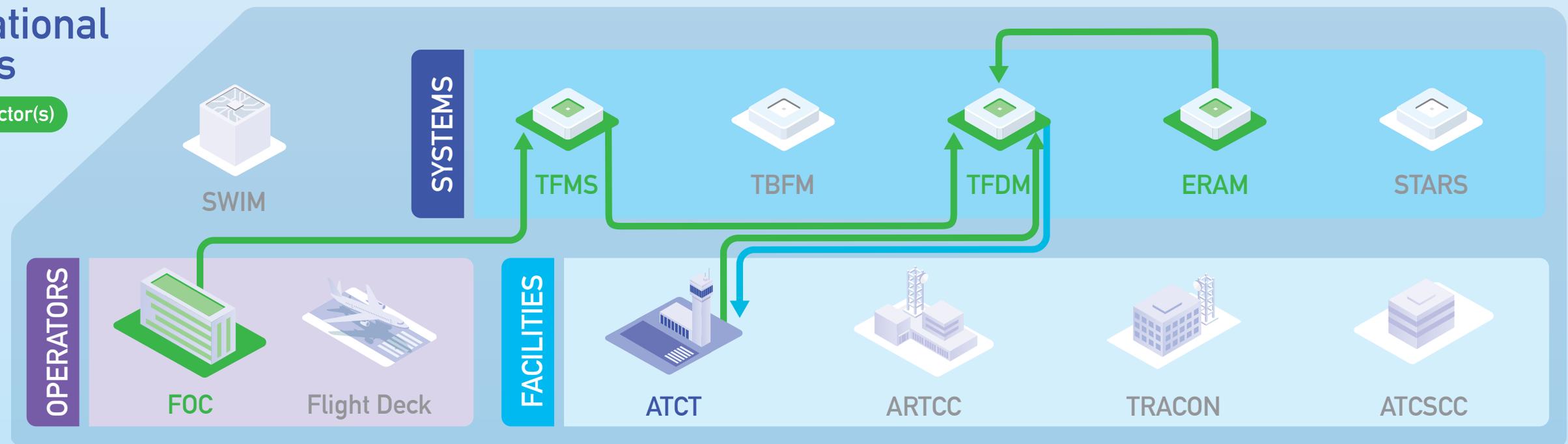
The new Terminal Flight Data Manager (TFDM) system will bring automation to airport surface, including electronic flight strips, surface scheduling and metering, runway load balancing, and integration with other decision support systems and external stakeholders.

ATCT personnel use runway load balancing tool to manage predicted runway imbalances. Based on expected demand, the tool develops a time-based schedule for each of the runways, and recommends changes in flight-specific runway assignments for ATCT's approval.

## Operational Actors

Current Actor(s)

Step 1/2



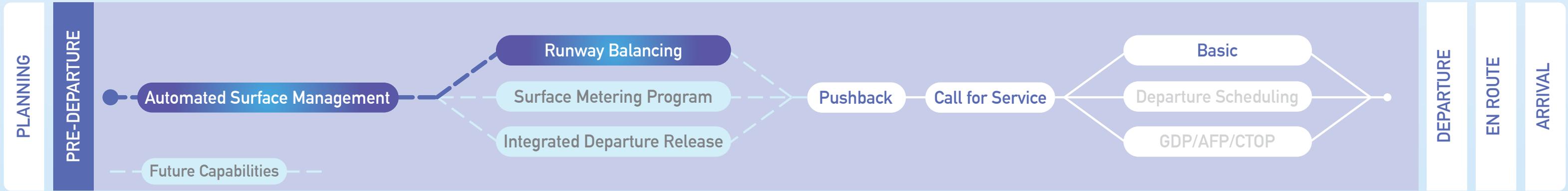
● **INPUTS:** →

Flight data

Flight-specific unacceptable runways (from FOC to TFMS, and from TFMS to TFDM)

● **OUTPUTS:** →

Runway-specific schedules and aircraft assignments



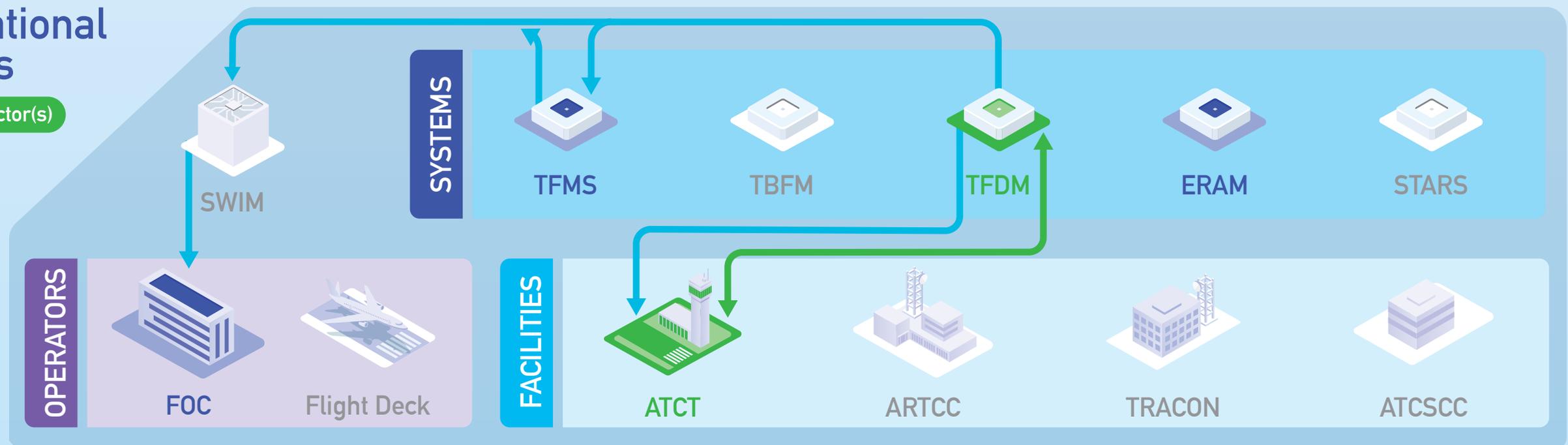
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## Operational Actors

Current Actor(s)

Step 2/2

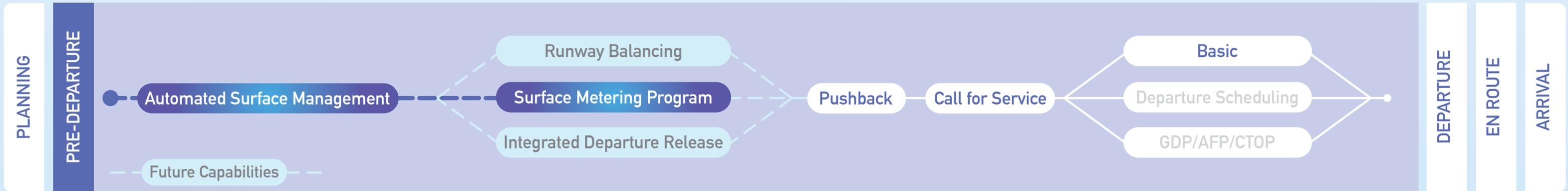


**ACTIONS:** →

TMCs evaluates and executes runway load balancing to resolve runway imbalances

**OUTCOMES:** →

Updated runway-specific schedules and aircraft assignments



The new Terminal Flight Data Manager (TFDM) system will bring automation to airport surface, including electronic flight strips, surface scheduling and metering, runway load balancing, and integration with other decision support systems and external stakeholders.

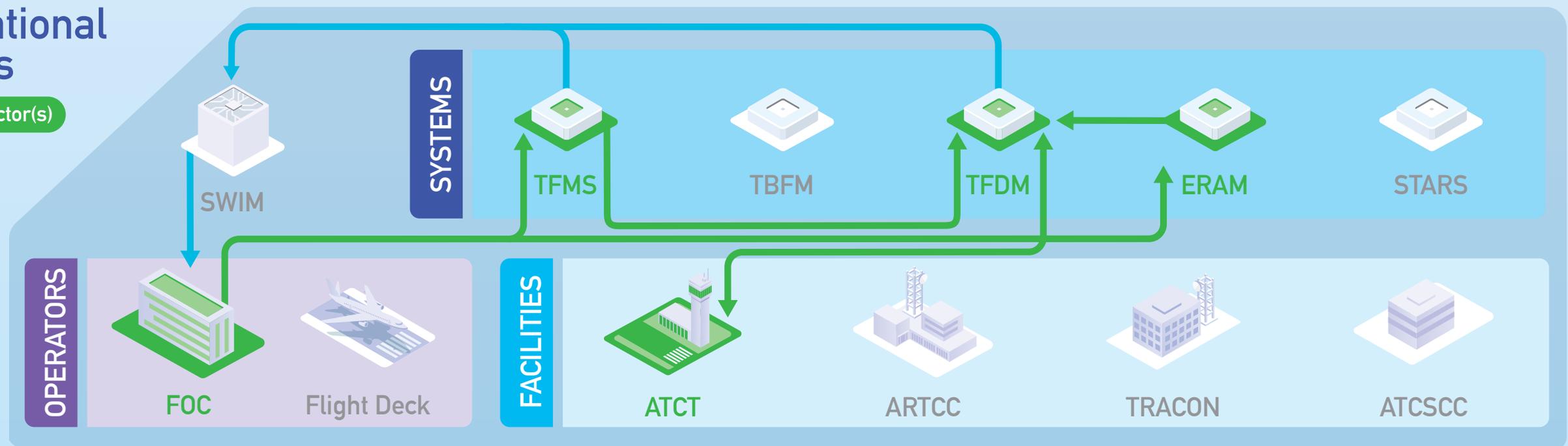
Surface Metering Program (SMP) provides tools to the controllers to more efficiently manage individual aircraft movement on airport surface. Typically triggered by sustained surface capacity/demand imbalances, surface metering capability will enable aircraft to absorb delays in virtual queues, which will then lead to a reduction in airport congestion and fuel burn.

When active, stakeholders receive SMP related information, and Flight Operators can substitute aircraft positions in SMP schedules to manage their business priorities.

## Operational Actors

Current Actor(s)

Step 1/2

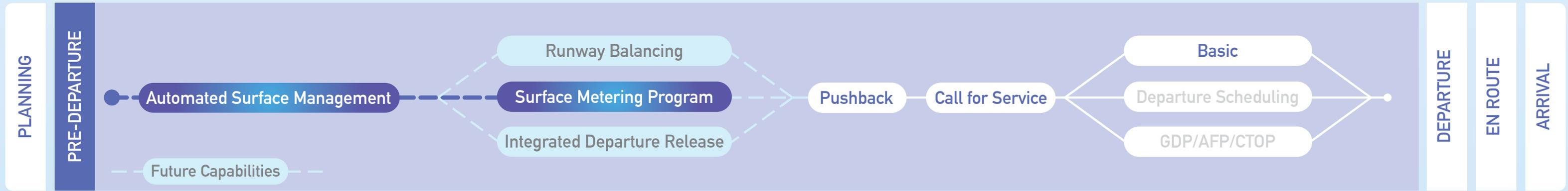


**INPUTS:** →

FOC provides flight data and flight substitution requests

**OUTPUTS:** →

Updated SMP schedules



The new Terminal Flight Data Manager (TFDM) system will bring automation to airport surface, including electronic flight strips, surface scheduling and metering, runway load balancing, and integration with other decision support systems and external stakeholders.

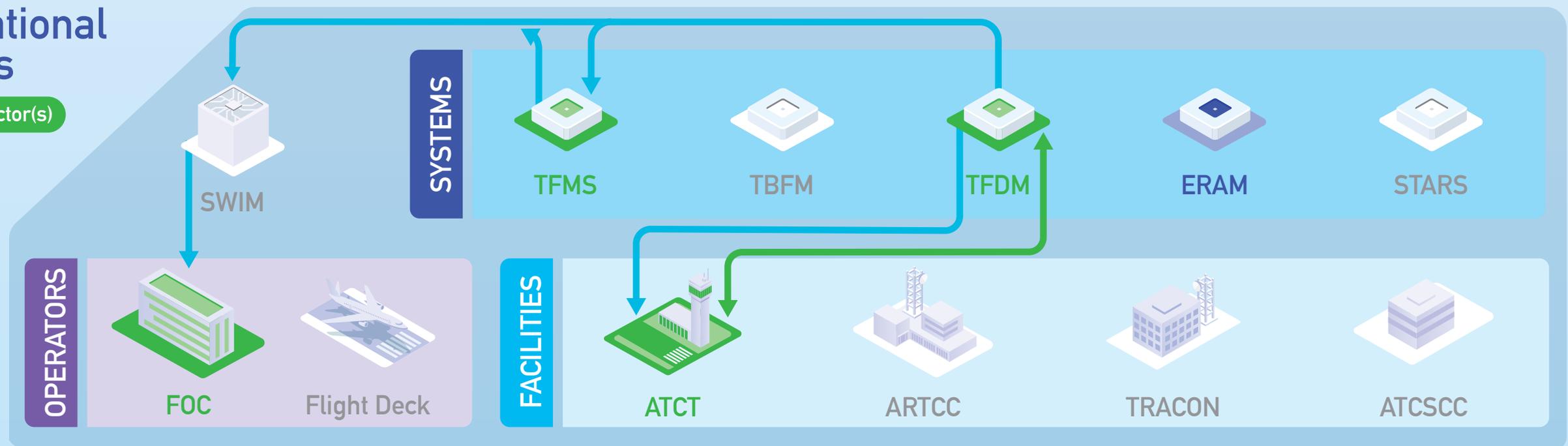
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## Operational Actors

Current Actor(s)

Step 2/2

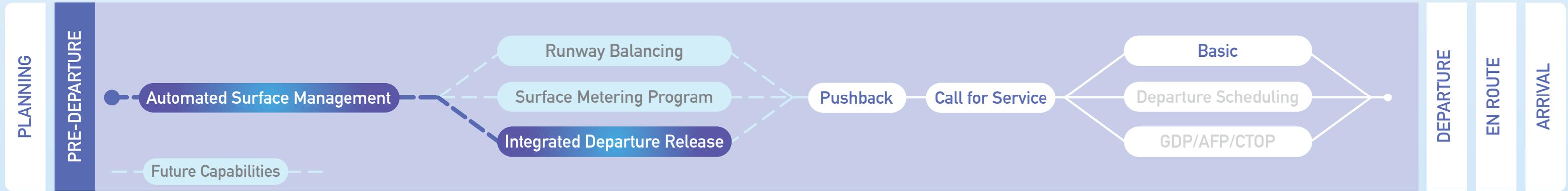


**ACTIONS:** →

ATCT TMCs evaluate and update SMP parameters

**OUTCOMES:** →

Updated SMP schedules to the stakeholders



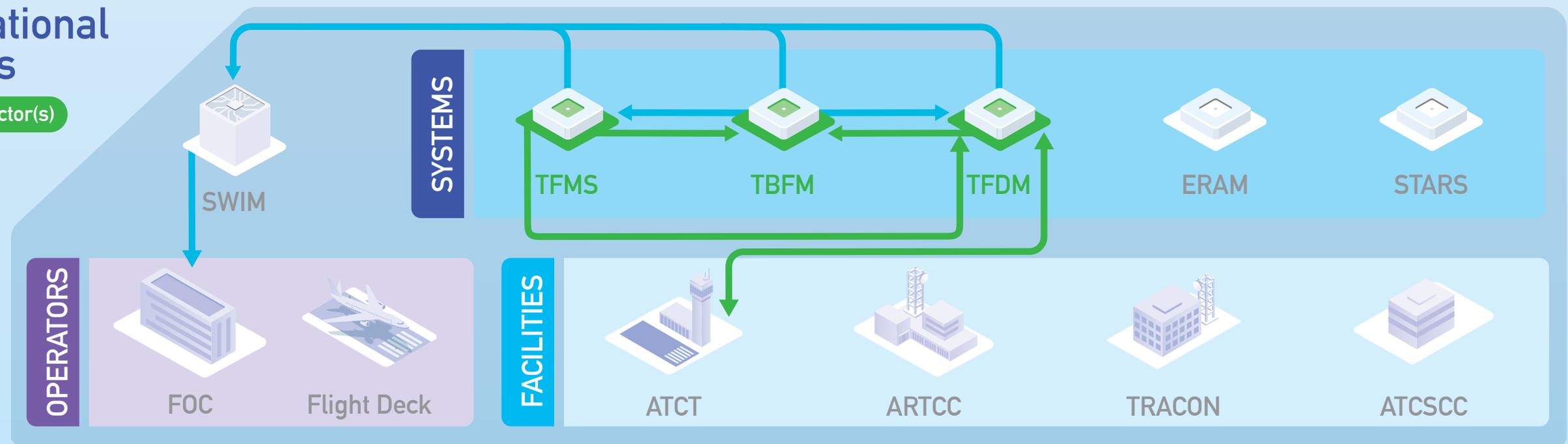
The new Terminal Flight Data Manager (TFDM) system automates and provides tools to manage the airport and optimize surface operations.

TFDM enables use of a consistent departure release time across TBFM, TFDM and TFMS automation platforms, leading to Integrated Departure Release management. TFDM also improves efficiency of departure scheduling by allowing automated initiation of release-requests in TBFM based on operating conditions and adaptation configuration. When establishing surface and runway-specific schedules, TFDM uses departure release times from TBFM or, when applicable, EDCTs from TFMS.

## Operational Actors

Current Actor(s)

Step 1/1

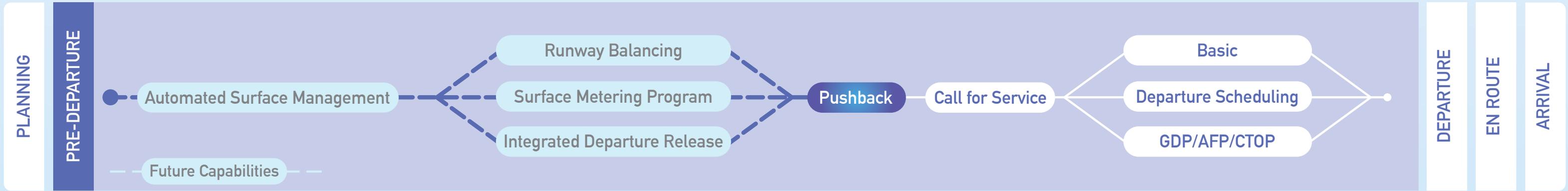


**INPUTS:** →

- TFDM requests release times from TBFM
- TFMS provides EDCTs if applicable

**OUTPUTS:** →

Updated demand prediction and time-based schedules are shared with stakeholders and systems.



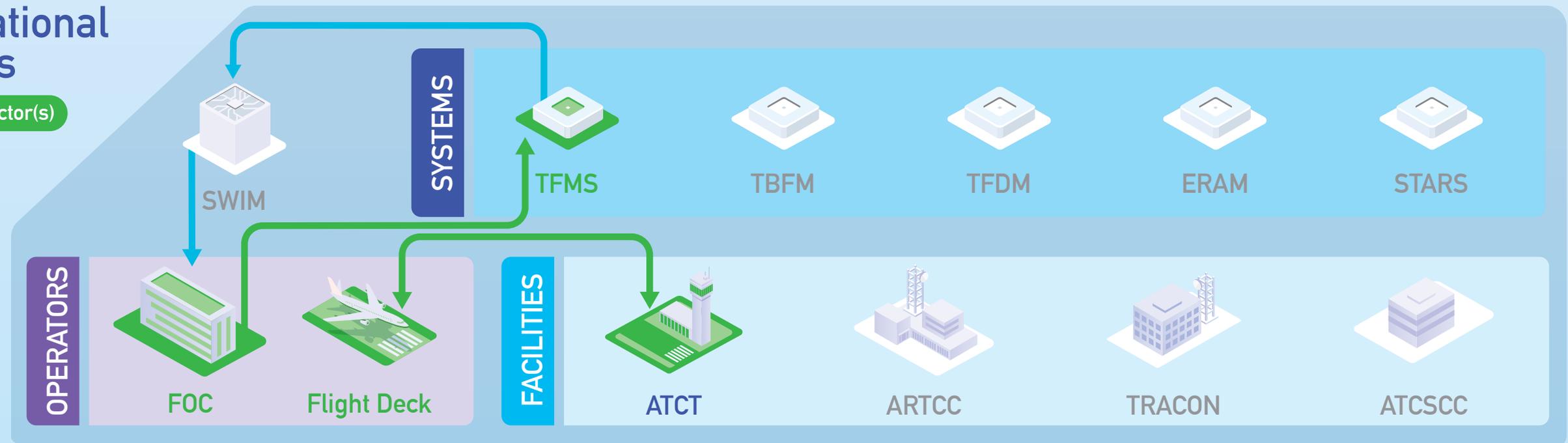
Flight Crew closes door, start the engines, and releases the brakes. Aircraft pushes from the gate into the ramp area.

Flight Crew calls ATCT to request Clearance Delivery, and receives the full route clearance. At airports with Tower CDPLC services, equipped aircraft receive routing clearances via CPDLC; otherwise, clearances are delivered via voice.

## Operational Actors

Current Actor(s)

Step 1/1

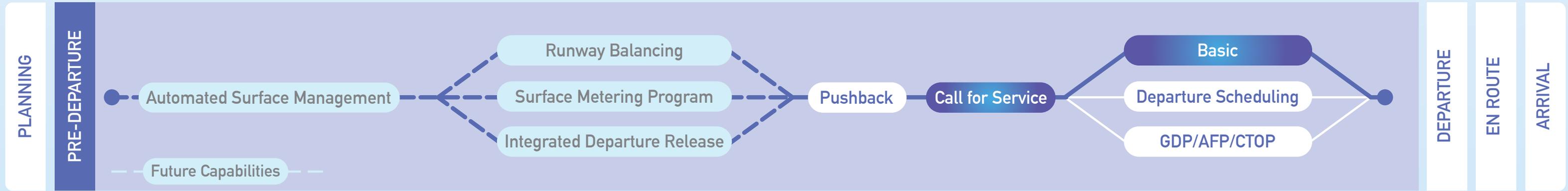


● **INPUTS:** →

ACARS equipped aircraft send OUT times to FOC  
FOC sends AOBT message to TFMS

● **OUTPUTS:** →

TFMS updates ETD, ETA, demand predictions and other tools/displays to stakeholders and other systems.



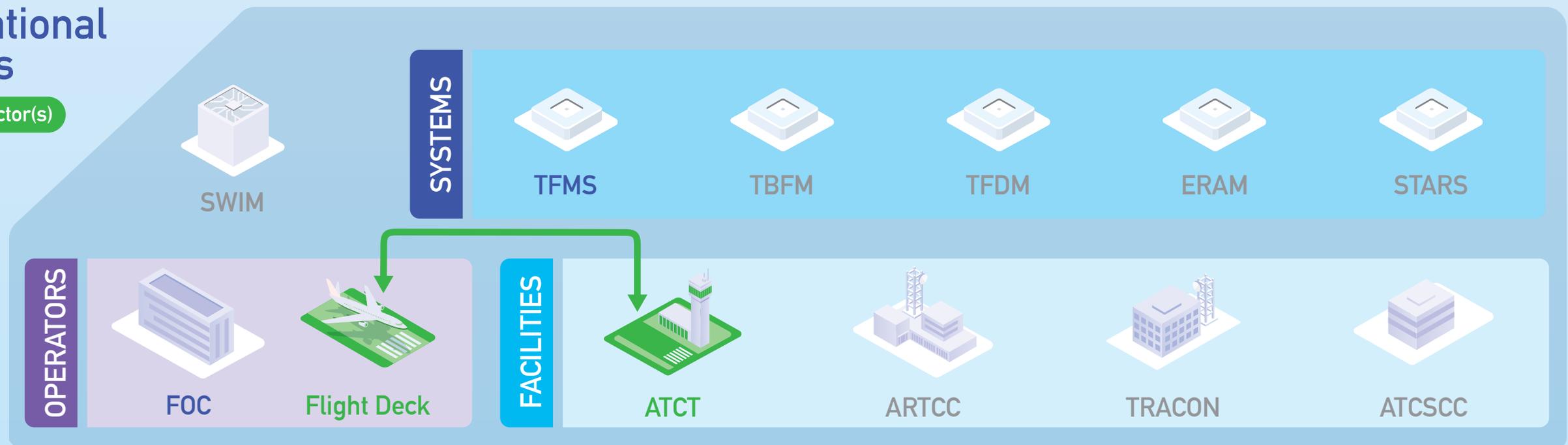
Flight Crew informs ATCT that aircraft is ready to enter movement area.

At major airports, Flight Crew first calls the Ramp Tower for a clearance to taxi in the ramp area, and ATCT for reaching the "spot" of entry into the movement area.

## Operational Actors

Current Actor(s)

Step 1/1



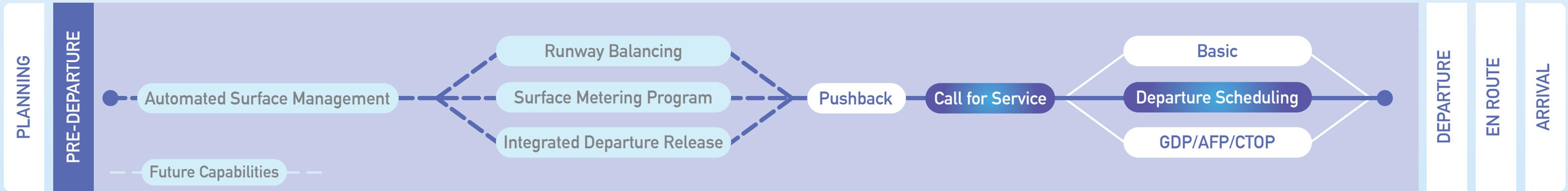
**ACTIONS:** →

Pilot notifies ATCT when ready to enter movement area.

At airports without Departure Scheduling, ATCT acknowledges call for service and provides instructions for taxi-out.

**OUTCOMES:** →

Flight Crew initiates taxi-out.



Departure scheduling helps with management of take-off times for aircraft that are expected to join constrained traffic flows along their filed route. This facilitates smooth merging of departures with aircraft that are already airborne, and smooth merging of aircraft through common fixes along their routes.

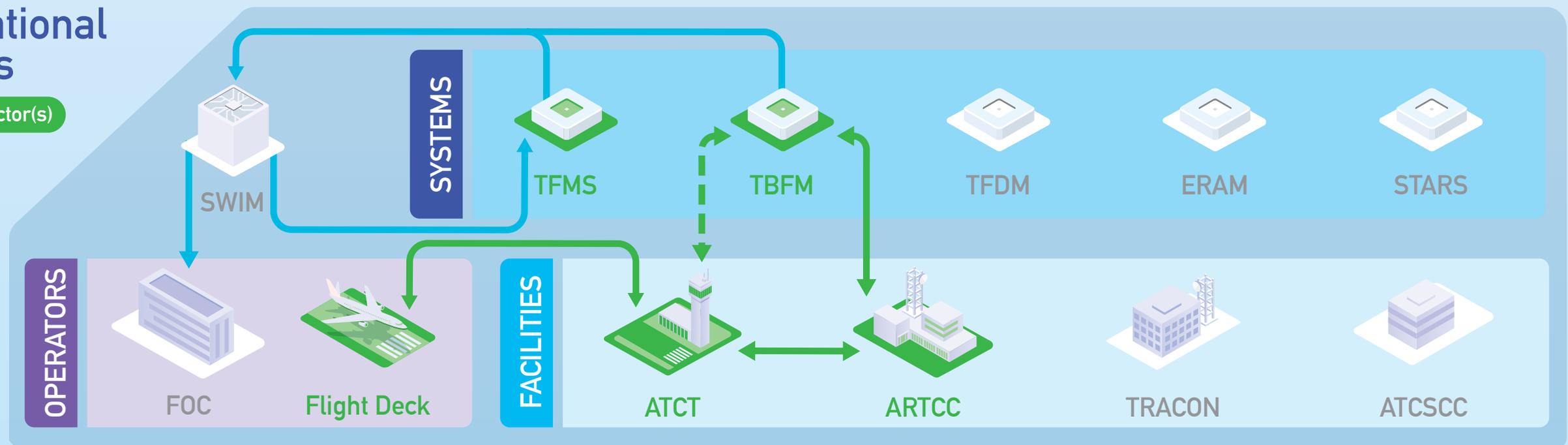
ATCT and ARTCC TMCs use TBFM to schedule departure release times based on desired spacing through common constraint points, current ETAs of relevant airborne traffic, and the estimated aircraft departure time. If necessary, TBFM recommends ground delays for departing aircraft to avoid airborne vectoring and holding that would otherwise be needed to sequence flights through the applicable merge point

Aircraft are expected to take-off within -2 and +1 minute of their Scheduled Departure Time.

## Operational Actors

Current Actor(s)

Step 1/1

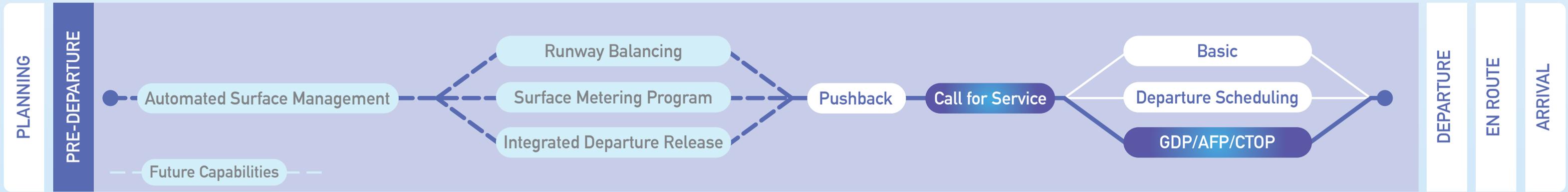


### INPUTS: →

- Flight Deck requests departure release time from ATCT.
- ATCT TMC request a departure release time from the ARTCC TMC.
- ARTCC TMC enters desired departure time into TBFM, receives the release time from TBFM, and relays it back to the ATCT TMC via voice, who writes onto to flight strip.
- If ATCT is using IDAC, they can obtain the departure release time directly from TBFM.

### OUTPUTS: →

- Aircraft is scheduled/placed onto the applicable TBFM Departure Timeline.
- ATCT provides taxi instructions to Flights Deck consistent with the Scheduled Departure Time.
- TBFM shares flight-specific Scheduled Departure Time via SWIM
- TFMS updates ETD, ETA, demand predictions and other tools/displays as needed.



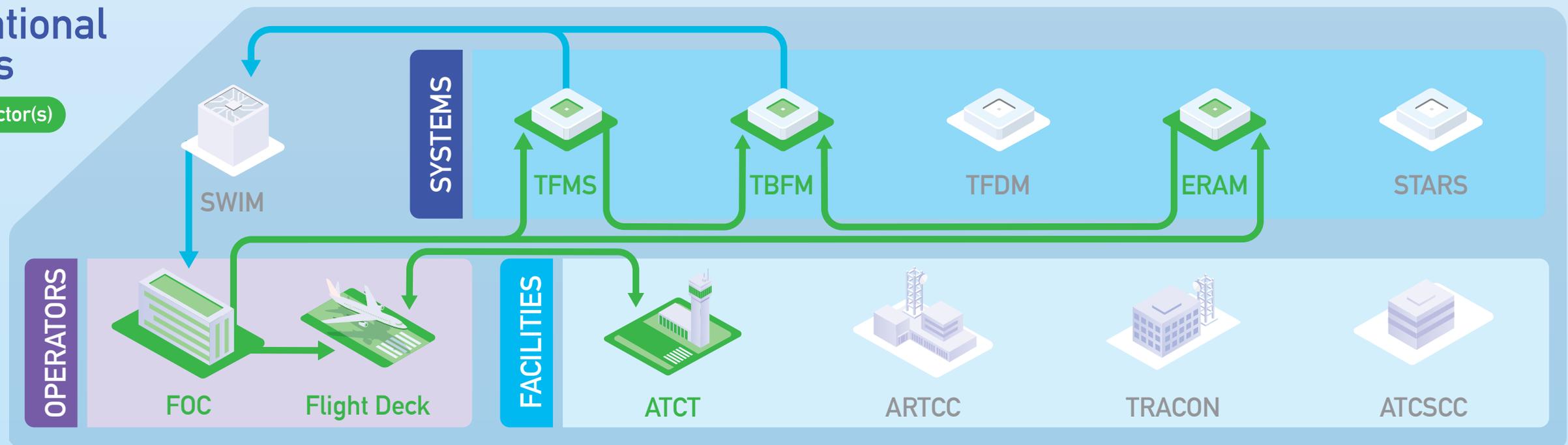
When aircraft are impacted by a strategic TMI – a GDP, AFP or CTOP – they will receive an Estimated Departure Clearance Time (EDCT) from TFMS. During active GDP and AFP events, Flight Operators can substitute slots for their flights to manage their business priorities.

Aircraft are expected to depart within +/-5 minutes of their EDCT to ensure the objectives of the program are met.

## Operational Actors

Current Actor(s)

Step 1/1



**INPUTS:** →

- Flight Data, including TOS and slot substitution requests from FOC
- EDCTs from TFMS to all Stakeholders
- Slot substitution requests

**OUTPUTS:** →

- Slot substitution acceptance and rejection
- Updated EDCT, ETD, ETA, demand projections and tools/displays in TFMS as needed
- Updated schedules and timelines in TBFM as needed



# Departure

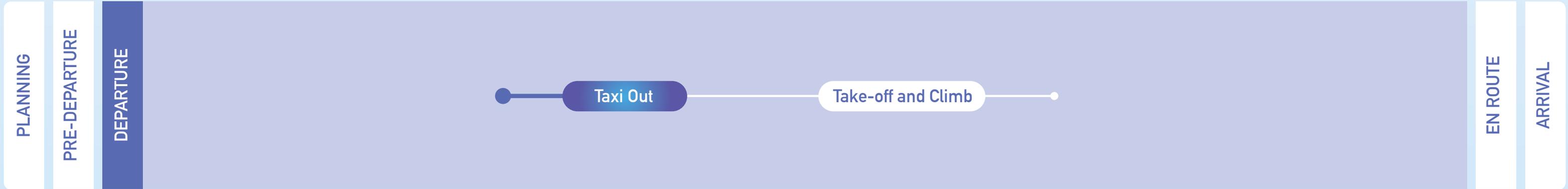
Departure phase begins as the flight enters the movement area and continues through top of climb.

## PLANNED OPERATIONAL IMPROVEMENTS:

- Delivery of pre-departure clearances to aircraft is faster and with fewer errors with Tower CPDLC
- Situational awareness of airport surface management and constraints is expanded to all stakeholders with TFDM, via SWIM and TFMS Surface Viewer
- Flexibility in making tactical trajectory adjustments is increased with automated coordination of pre-departure re-routes
- Tactical route management accounts for operator preferences through use of TOS

## CHALLENGES:

- Currently, departure release times and pre-departure reroutes are coordinated manually.
- Traffic management personnel does not have decision support tools to estimate departure delays prior to submitting a reroute.
- Without Surface Viewer capabilities, TRACONs, ARTCCs, and the ATCSCC lack tools that provide insights into operations on the airport surface
- Surface Metering Program information must be manually entered into NTML before it is forwarded to TFMS
- Not all flights are CPDLC equipped, requiring manual clearance coordination
- To maximize TFDM surface metering benefits, participation, data submission, and compliance is required by operators



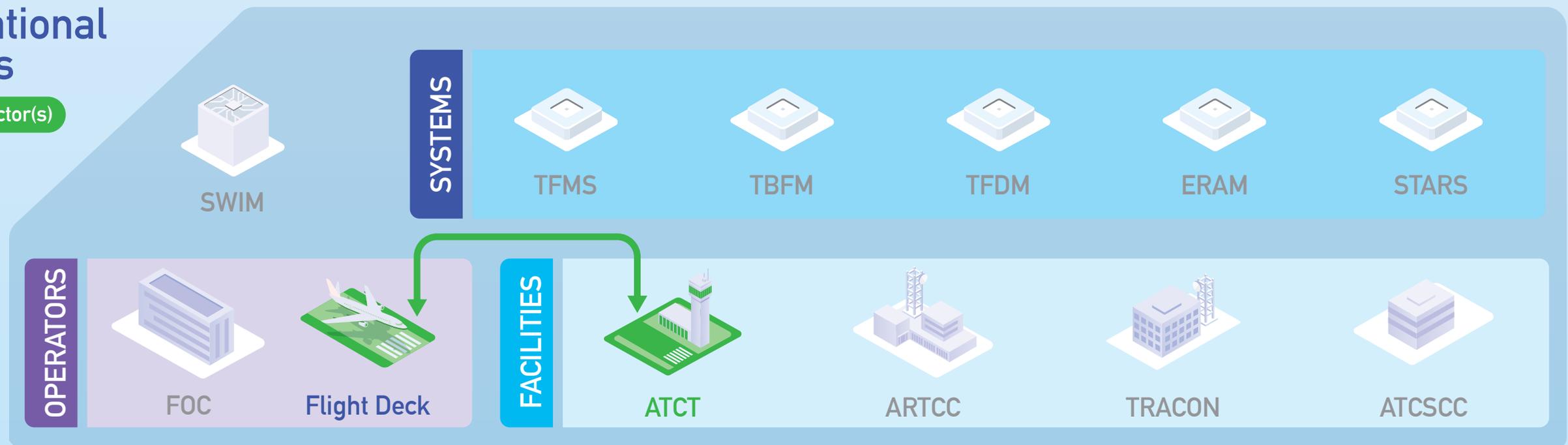
Aircraft taxis to the departure runway consistent with ATCT controller instruction.

At airports with Tower CDPLC services, equipped aircraft receive taxi clearance via CPDLC; otherwise, these clearances are delivered via voice. Electronic Tower Services are delivered faster and with fewer misunderstandings compared to the same instruction issued via voice.

## Operational Actors

Current Actor(s)

Step 1/1

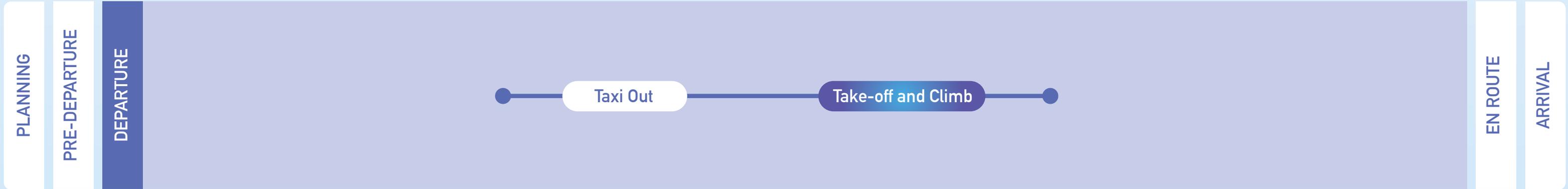


**ACTIONS:** →

Flight Crew requests and receives taxi-clearance from ATCT controller.

**OUTCOMES:** →

Aircraft taxis to departure runway consistent with taxi-clearance.



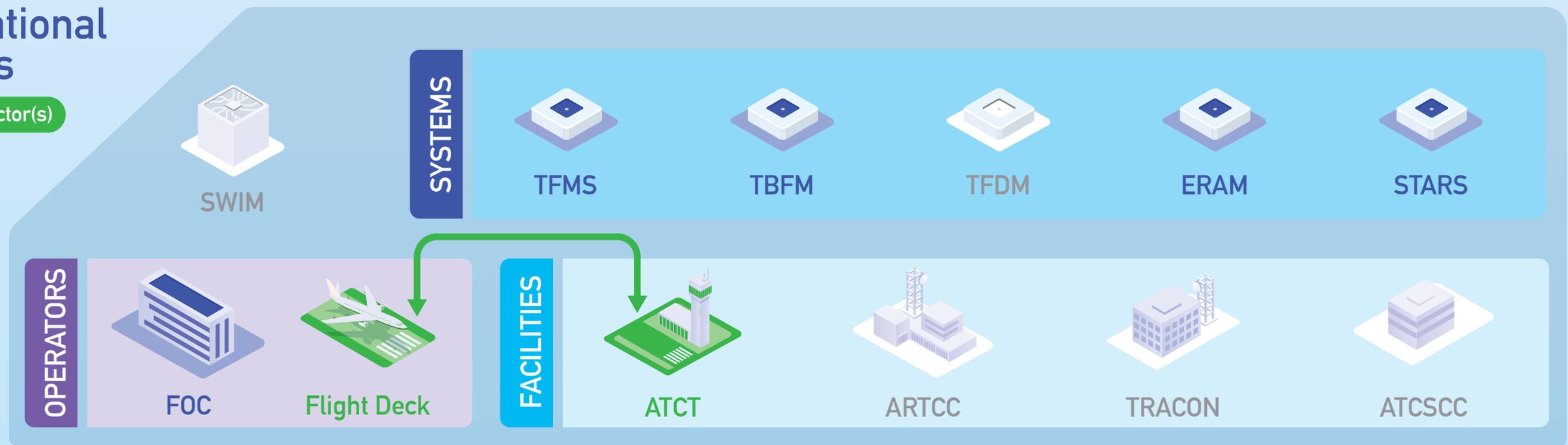
Aircraft takes-off from the departure runway consistent with ATCT controller instruction.

At airports with Tower CDPLC services, equipped aircraft receive departure clearances via CPDLC; otherwise, these clearances are delivered via voice. Electronic Tower Services are delivered faster and with fewer misunderstandings compared to the same instruction issued via voice.

## Operational Actors

Current Actor(s)

Step 1/2

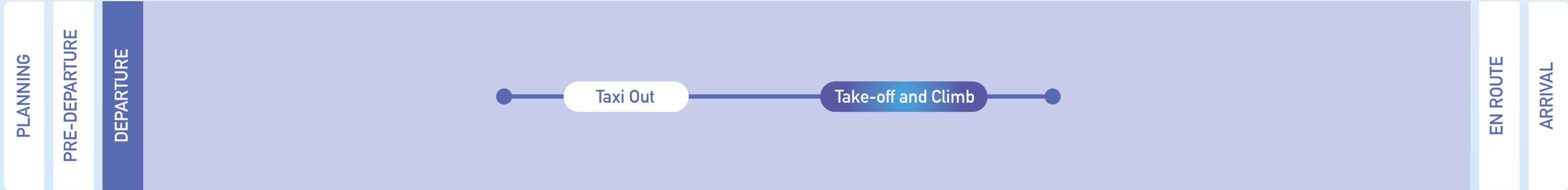


● **ACTIONS:** →

Flight Crew requests and receives take-off clearance from ATCT controller.

● **OUTCOMES:** →

Aircraft takes off from departure runway consistent with take-off clearance.



After take-off, flight is acquired by radar and flight tracking begins.

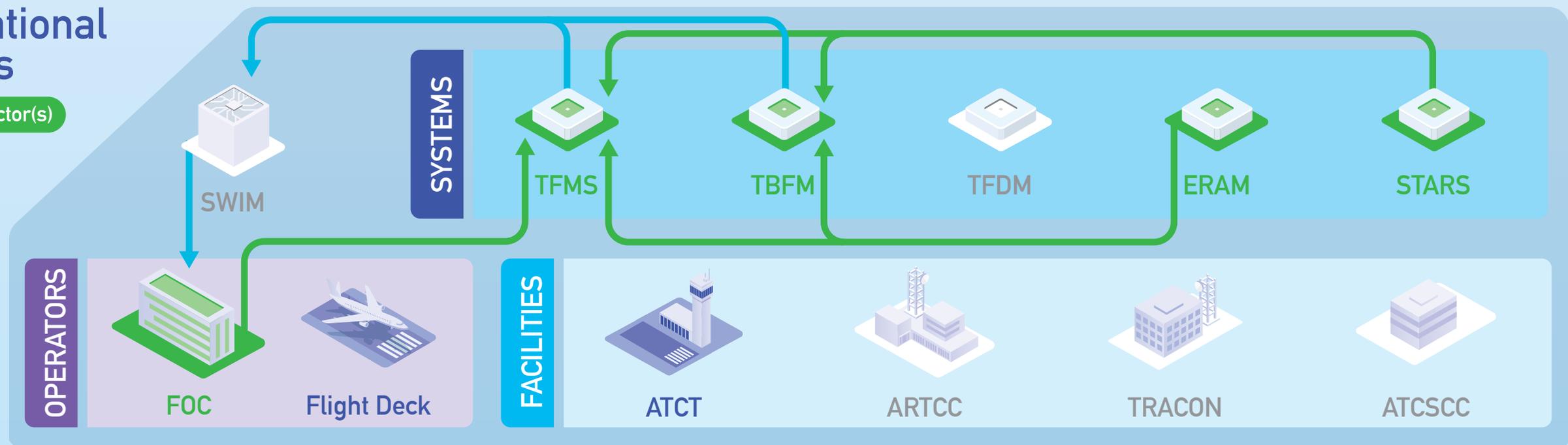
TRACON controller monitors progress of climb through terminal airspace, and provides control instructions as needed via voice.

The aircraft continues to climb into en route airspace until it reaches cruise altitude.

## Operational Actors

Current Actor(s)

Step  
2/2



**INPUTS:** →

ACARS equipped aircraft broadcast OFF time, and FOC provides ATOT to TFMS.

ERAM and STARS receive track updates, sets ARTD and shares with other systems.

**OUTPUTS:** →

TFMS uses track updates to refine its ETAs, demand predictions and other tools/displays as needed.

TBFM updates its own ETAs, STAs and timelines as applicable, and shares flight-specific information with stakeholders.



# En Route

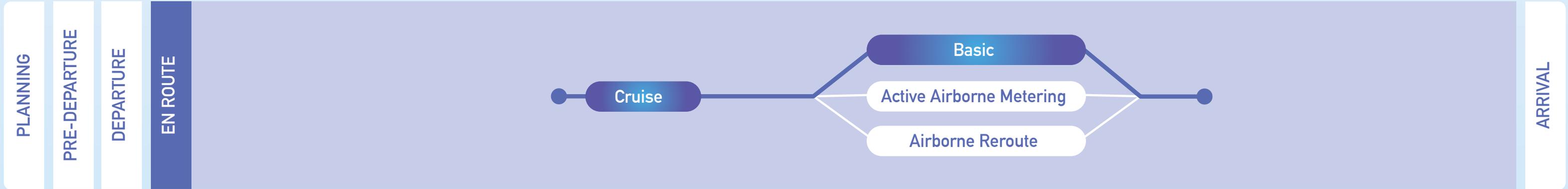
En Route phase continues from top of climb through top of descent.

## PLANNED OPERATIONAL IMPROVEMENTS:

- Increased use of TBM
  - Spacing between aircraft is applied only when needed
  - Reduced use of static MIT restrictions that require specified spacing between all aircraft in the flow
  - Delays are distributed across longer distances, and absorbed at higher altitudes or on ground at origin airports
  - The need for vectoring is reduced, leading to increased conformance to filed routes and improved predictability
- Time-based schedules are available to Flight Operators via SWIM
- Initial En Route CPDLC deliver routine clearances to aircraft faster and with fewer errors
- Increased flexibility in tactical trajectory adjustments via automated coordination of Airborne Re-routes allows

## CHALLENGES:

- En route controllers have limited decision support tools to help them meet time-based schedules
- ARTCC does not have decision support tools to help them test if-then scenarios before implementing a significant change in traffic flow management



Flight reaches cruising altitude, and proceeds to its destination based on its flight plan routing and ARTCC controller instructions.

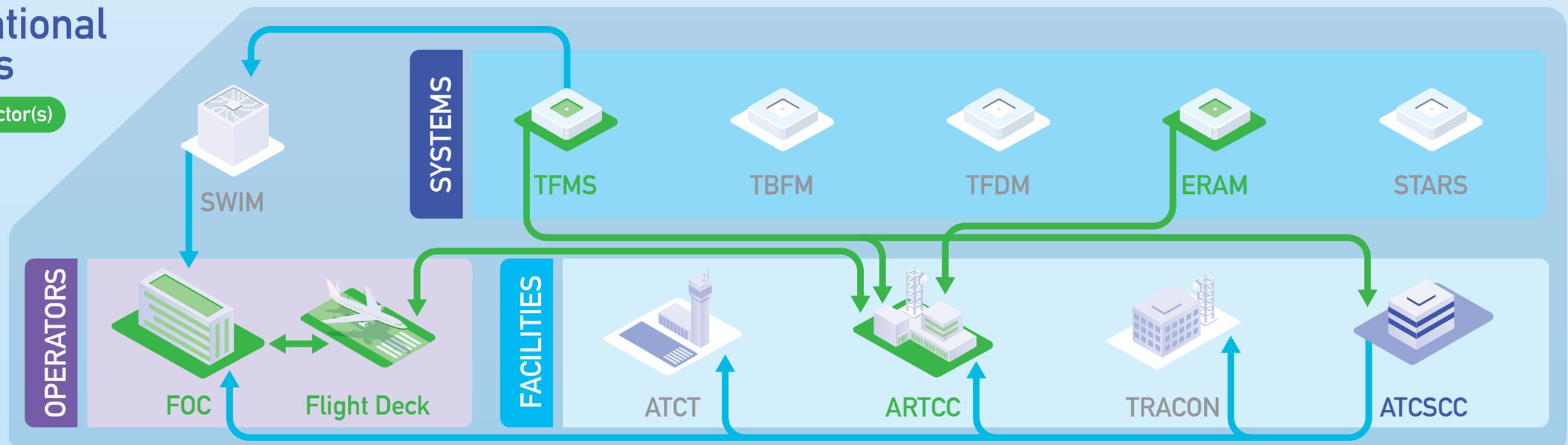
ERAM continues to track flight progress.

In centers with Initial En Route CDPLC Services, equipped aircraft receive routine clearances via CPDLC; otherwise, these clearances are delivered via voice. Electronic communications are delivered faster and with fewer misunderstandings compared to the same instruction issued via voice.

## Operational Actors

Current Actor(s)

Step  
1/2



● **ACTIONS:** →

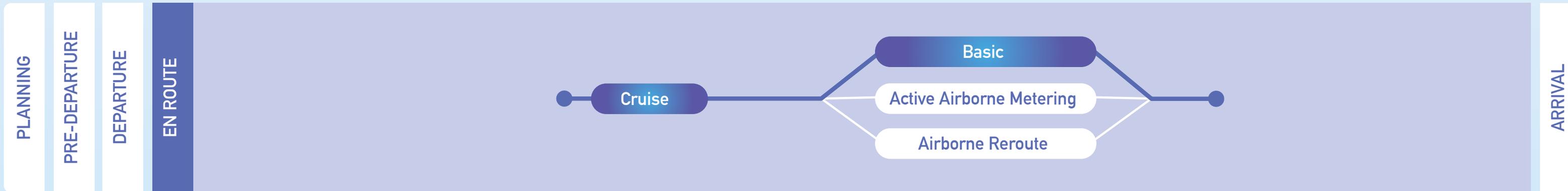
ARTCC controller issues instructions as needed.

ATCSCC monitors TFMS tools/displays, and coordinates with stakeholders as needed.

FOC receives flight status updates via SWIM, and coordinates with Flight Crew as needed.

● **OUTCOMES:** →

Flight Crew operates aircraft consistent with filed routing and ARTCC controller instructions.



Flight reaches cruising altitude, and proceeds to its destination based on its flight plan routing and ARTCC controller instructions.

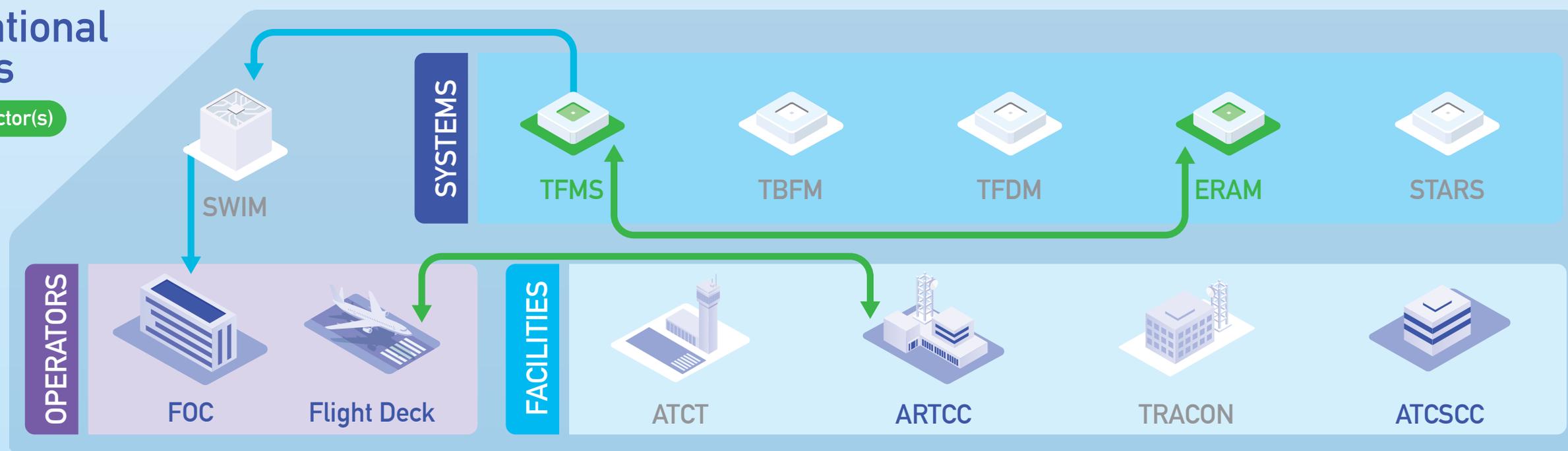
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## Operational Actors

Current Actor(s)

Step  
**2/2**

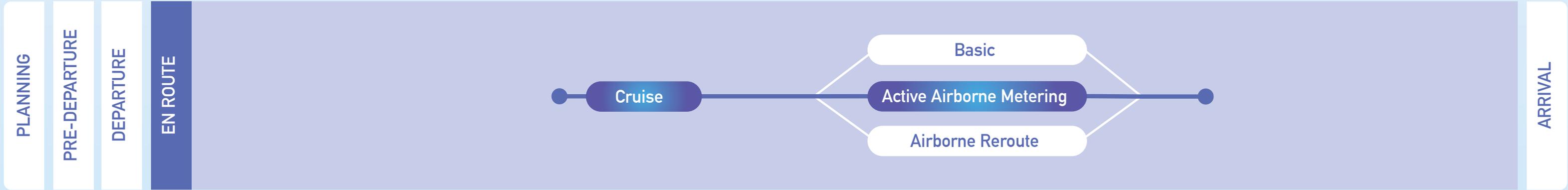


● **INPUTS:** →

ERAM receives track updates, and shares them with TFMS.

● **OUTPUTS:** →

TFMS uses track updates to refine its ETAs, demand predictions and other tools/displays as needed.



Airborne metering helps ARTCCs manage aircraft merging through congested constraint points along their filed routes. TBFM develops aircraft sequences and times (schedules or timelines) for each adapted constraint point, and applies spacing between specific aircraft pairs rather than uniformly between all aircraft in the flow.

When airborne metering is actively used, ERAM receives flight specific STAs and delays, and displays meter lists for each of the applicable constraint points on controller scope ("times on the glass").

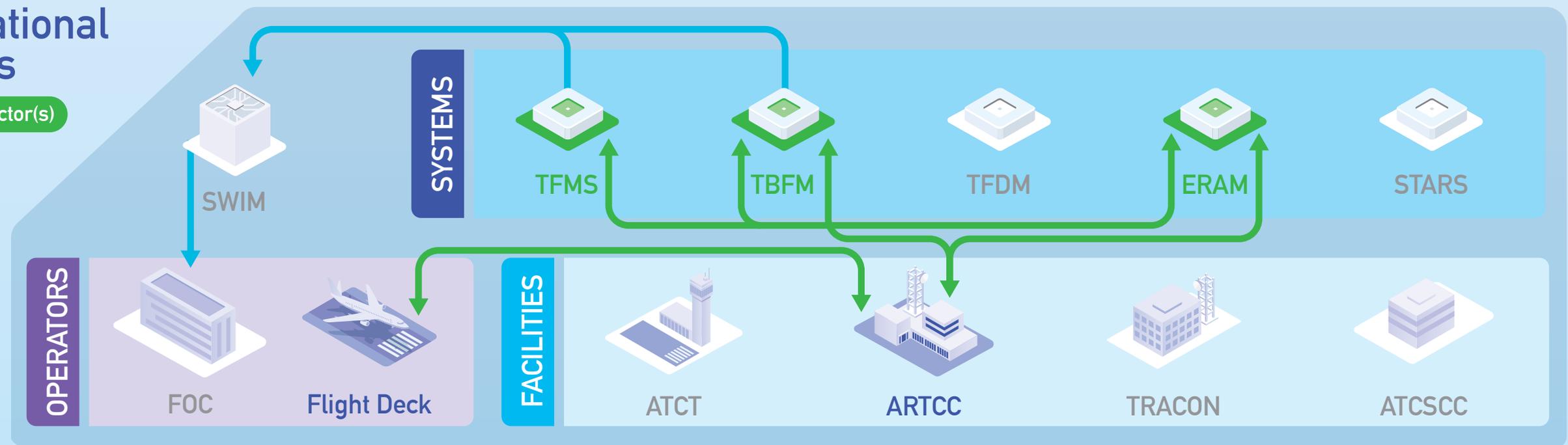
Flight Crew are typically not aware that airborne metering is active.

ARTCC TMCs monitor and adjust timelines as needed. ARTCC controllers are expected to deliver aircraft to the constraint point within +/- one minute of their STAs, and may adjust meter lists as needed too.

## Operational Actors

Current Actor(s)

Step 1/1



**INPUTS:** →

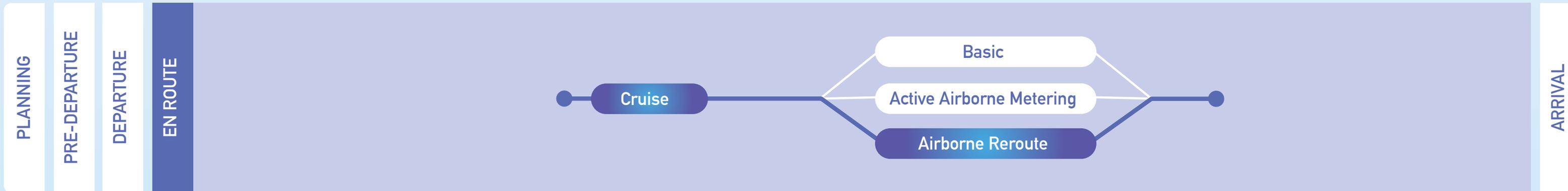
ERAM receives track updates, and shares them with TFMS and TBFM.

When metering is active, ARTCC controller sees applicable TBFM meter list on their scope.

**OUTPUTS:** →

TFMS uses track updates to refine its ETAs, demand predictions and other tools/displays as needed.

TBFM updates its own ETAs, STAs and timelines as applicable, and shares flight-specific information with stakeholders.



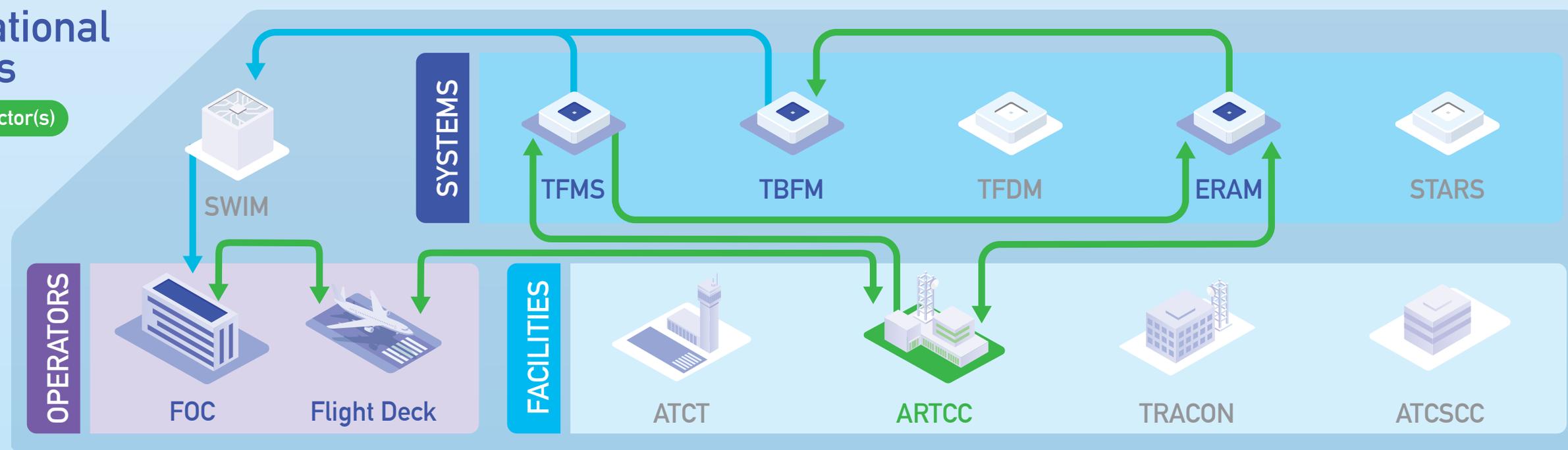
If, based on traffic conditions or emerging weather, ARTCC TMC identifies the need to change flight's filed route, they will coordinate a reroute with Flight Operators. FOC may also initiate a reroute request as needed, through its Flight Crew or through a direct coordination with Traffic Management Unit.

ARTCC TMC creates a route amendment in TFMS, which forwards it to ERAM via ABRR. ARTCC controller delivers the reroute to Flight Crew via voice or En Route CPDLC. Flight Crew updates their FMS as needed, and continues operating aircraft consistent with the new routing and controller instructions

## Operational Actors

Current Actor(s)

Step 1/1



● **ACTIONS:** →

- ARTCC TMC creates a route amendment in TFMS.
- TFMS forwards reroute to ERAM via ABRR, and ERAM shares it with TBFM.
- ARTCC controller delivers rerouting clearance to Flight Crew.

● **OUTCOMES:** →

- TFMS updates ETA, demand predictions and other tools/displays as needed.
- TBFM updates ETA, STAs, delays and timelines as applicable, and shares with stakeholders via SWIM.



# Arrival

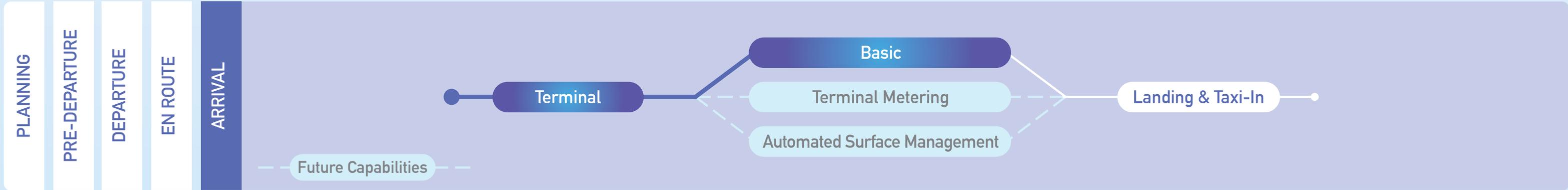
The arrival phase commences at top of descent and continues through landing and parking at the gate.

## PLANNED OPERATIONAL IMPROVEMENTS:

- Timing of aircraft entry into terminal airspace is improved with Airborne Metering, leading to reduced vectoring and shorter downwinds
- TSAS provides decision support to controllers to meter aircraft inside terminal airspace
  - Increased accuracy of time-based schedules for arrival runways, and compliance to the schedules
  - Improved ability to manage mixed equipage
  - Increased use of PBN approach procedures
- Arrival airport surface management is improved through integration of TFDM and TBFM (and sharing of arrival runways and times)

## CHALLENGES:

- Without TSAS, TRACON and ATCT controllers do not have insight into the time-based schedule, and have limited tools for merging and spacing aircraft or managing mixed equipage

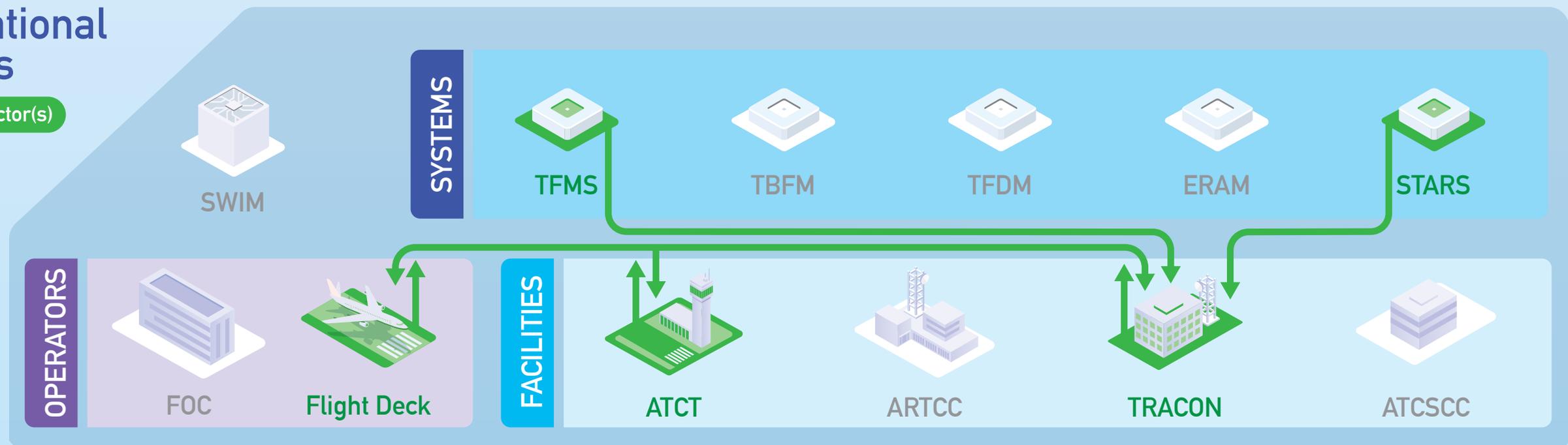


As the flight approaches its destination, it begins to descend and enters terminal airspace, where it finishes its transition from high altitude En Route operations, and follows ATC instructions that merge and sequence it onto approach path to arrival runway.

## Operational Actors

Current Actor(s)

Step 1/2

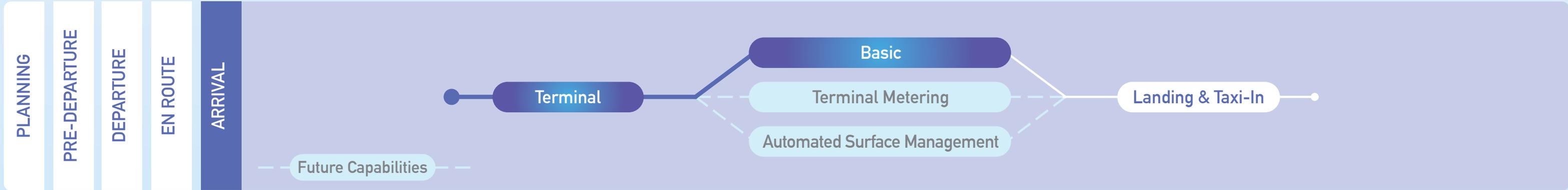


**ACTIONS:** →

- TRACON controllers direct aircraft onto their approach path as needed, and hand it off to ATCT
- TRACON TMCs monitor traffic flow via TFMS displays
- ATCT controller directs aircraft as needed and provides landing clearance

**OUTCOMES:** →

- Flight Crew operates aircraft consistent with TRACON and ATCT controller instructions, and executes landing clearance.

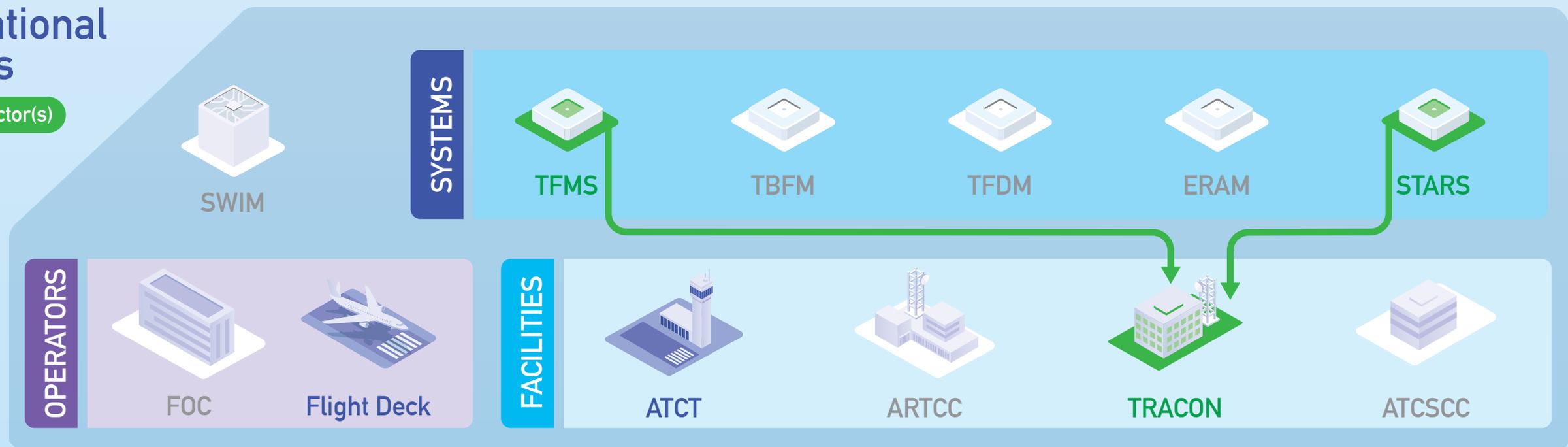


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## Operational Actors

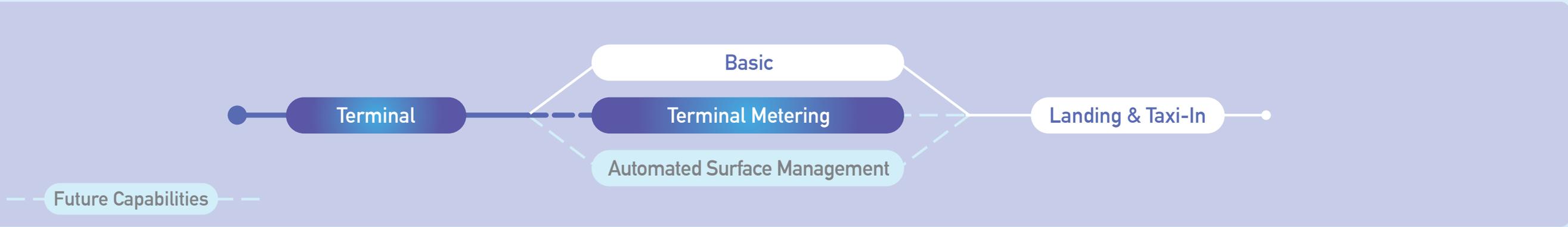
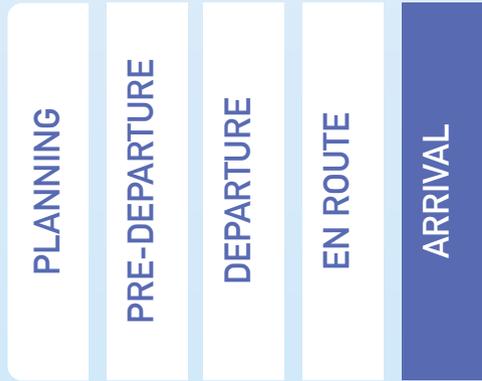
Current Actor(s)

Step  
2/2



**INPUTS:**  Track updates from radar feed

**OUTPUTS:**  Updated TRACON controller displays



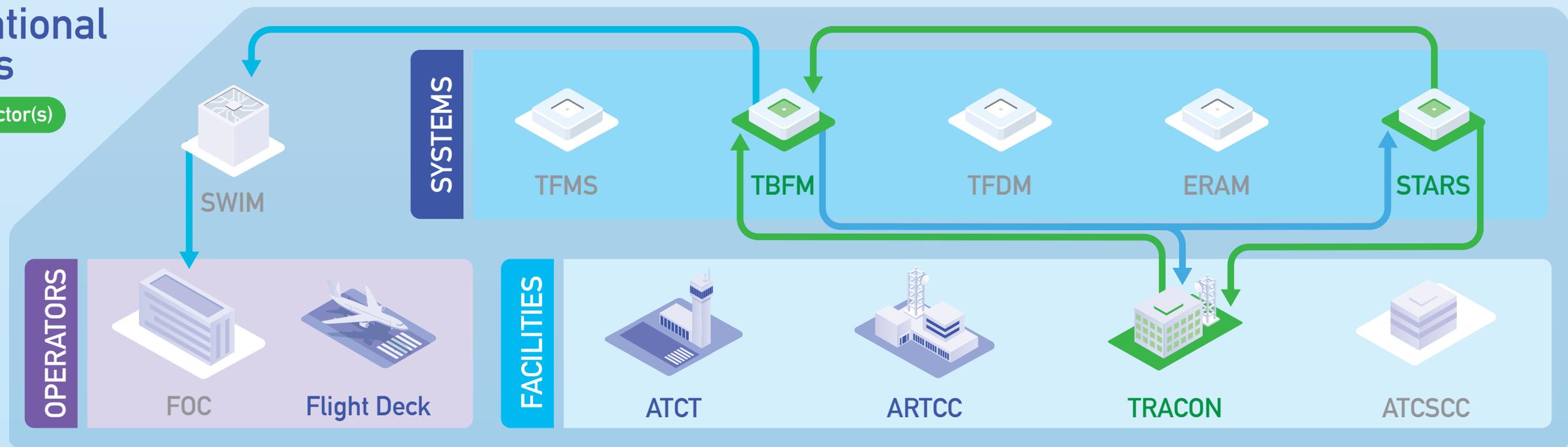
Integral to TBFM, TSAS will bring TBM into the terminal airspace by providing more accurate trajectory modeling and decision support tools for TMCs and controllers to help them maintain the time-based schedules all the way to the arrival runways.

For each aircraft, TSAS recommends a range of speeds that upholds its sequence through each merge point. TSAS algorithms estimate aircraft times to the arrival runway based on their filed routing inside terminal airspace, and account for differences between conventional and PBN approach procedures to the same runway. As a result, TSAS will increase use of and conformance to PBN procedures, including RNP approaches.

## Operational Actors

Current Actor(s)

Step 1/2



**INPUTS:**  Flight Data and track updates

**OUTPUTS:**  Flight-specific runway assignment, STA, and speed advisories



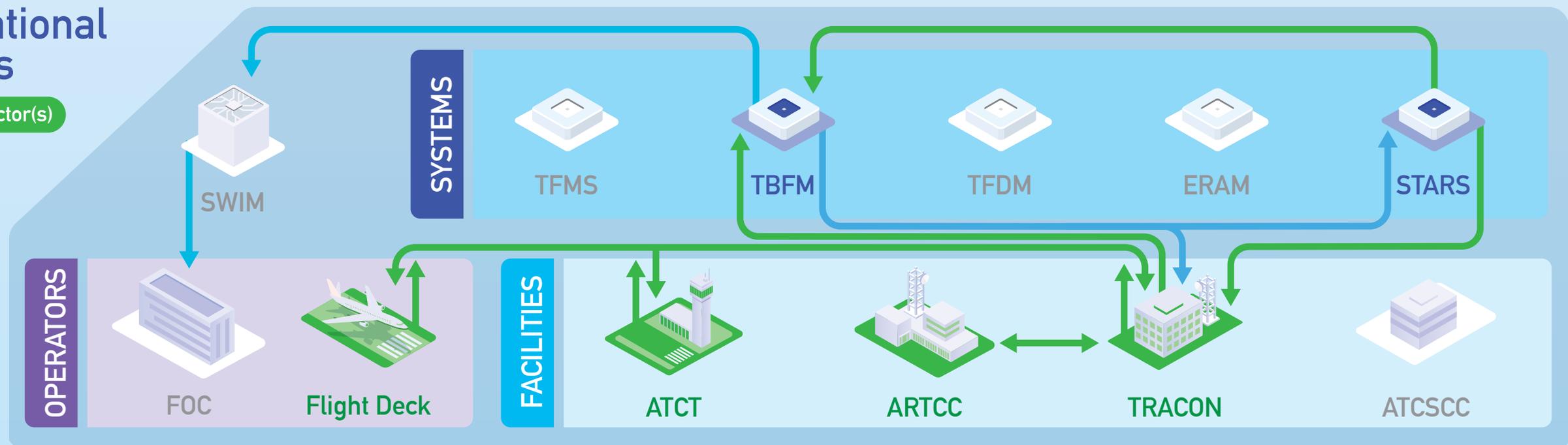
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## Operational Actors

Current Actor(s)

Step  
2/2

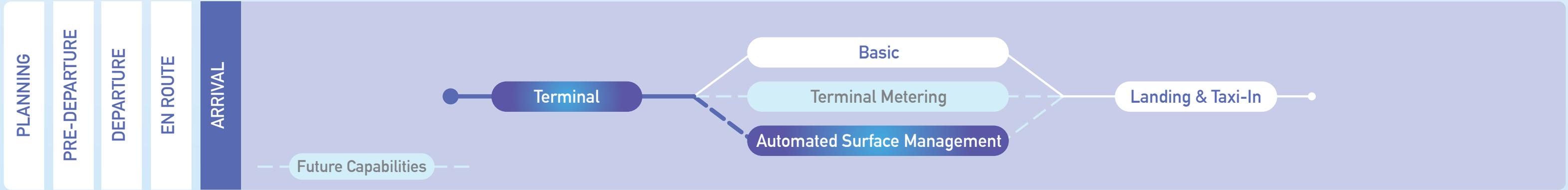


**ACTIONS:** →

- TRACON TMCs monitor traffic via TFMS or TBFM displays, and adjust TSAS runway assignments and sequences as needed
- TRACON controllers direct aircraft by using TSAS runway assignment, sequence, slot markers, and speed advisories, and hand the flight off to ATCT for landing.
- ATCT controllers direct aircraft as needed and provide clearance to land.

**OUTCOMES:** →

- Flight Crew operates aircraft consistent with TRACON and ATCT controller instructions.

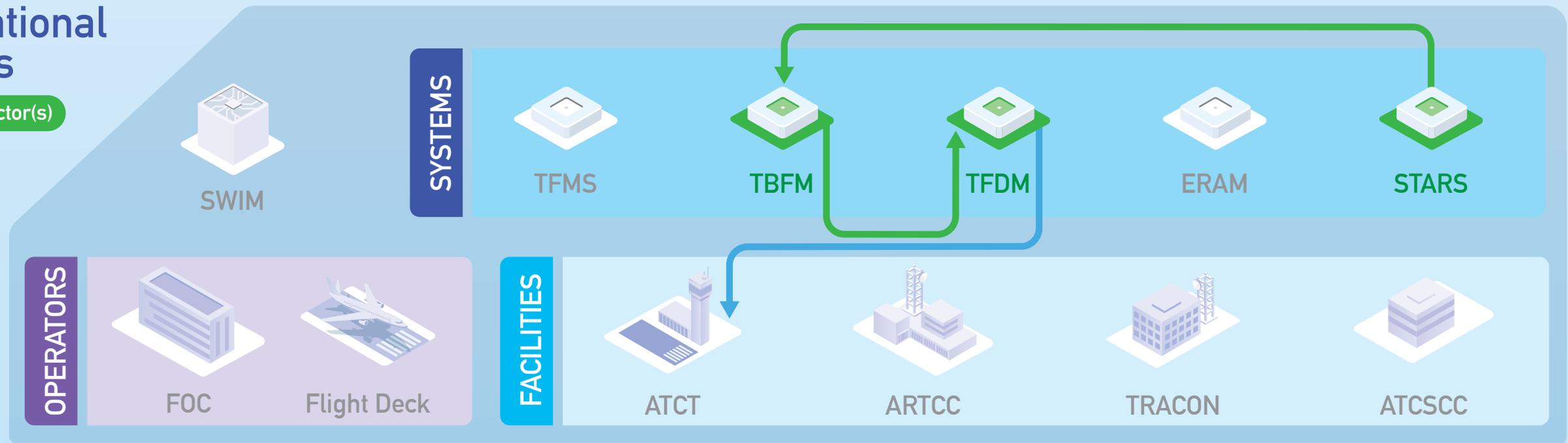


As the aircraft approaches its destination, TFDM begins receiving ETA and STA updates from TBFM, and updates its runway schedules accordingly. Increased accuracy in expected arrival time enables improved surface management at the destination.

## Operational Actors

Current Actor(s)

Step 1/1

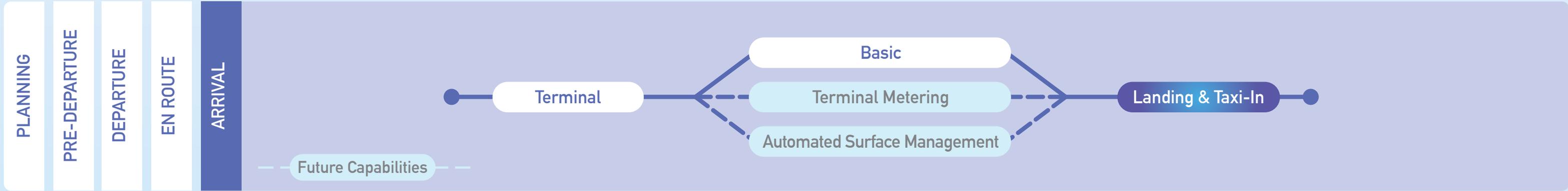


**INPUTS:** →

- STARS shares flight track updates with TBFM and TFDM
- TBFM provides flight-specific ETAs and STAs for each runway to TFDM

**OUTPUTS:** →

- Updated runway schedules
- Identified gate and alleyway conflicts
- TFDM publishes actual and estimated landing and in block times



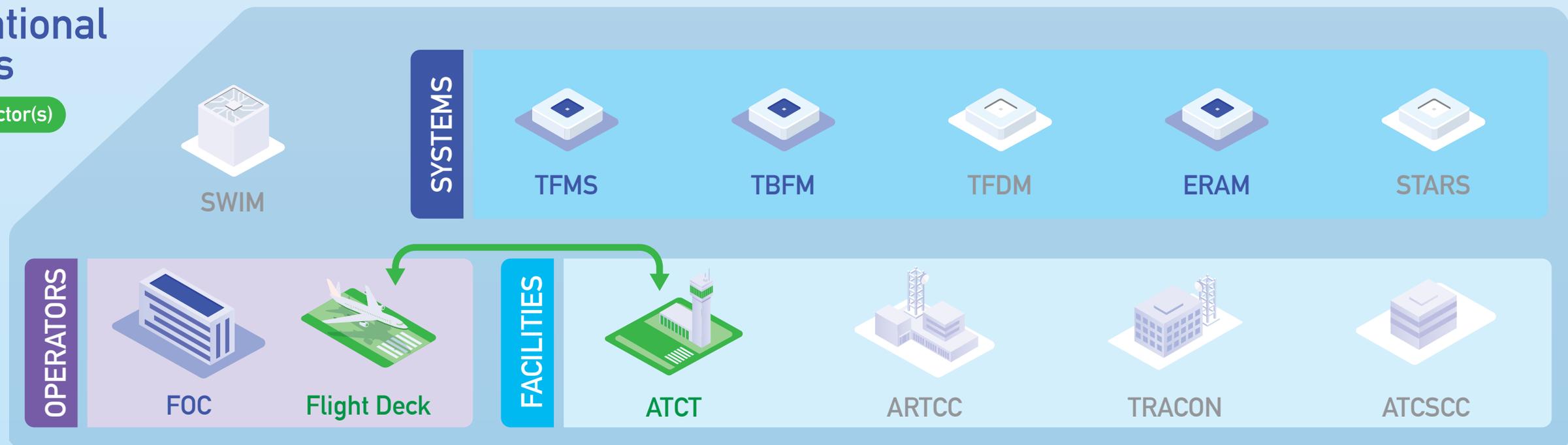
As the aircraft approaches its arrival runway and lands, radar coverage ends.

After landing, flight follows ATC instructions, and taxis to the gate.

## Operational Actors

Current Actor(s)

Step  
**1/2**

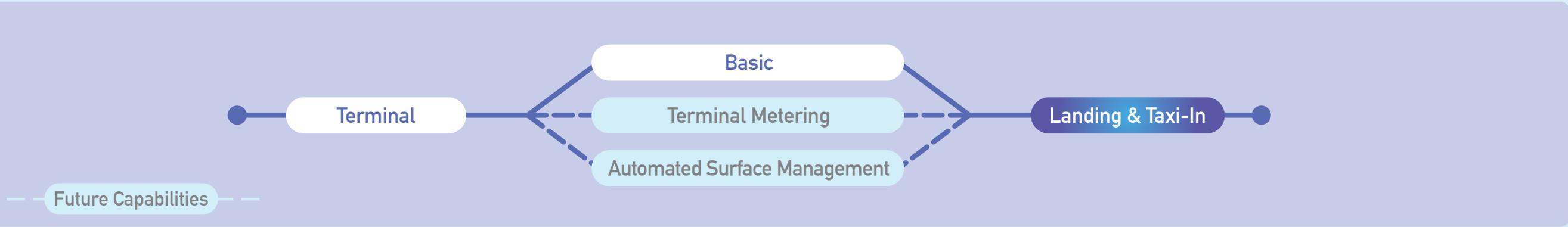
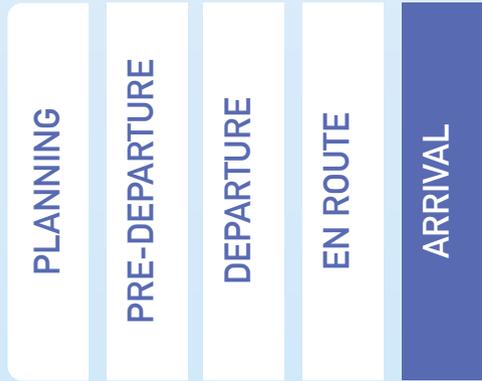


**ACTIONS:** →

- Flight Crew lands the aircraft, and exits the runway.
- ATCT provides taxi-in instructions to gate.
- Flight Crew taxis to the gate.

**OUTCOMES:** →

- Flight Crew concludes the flights.



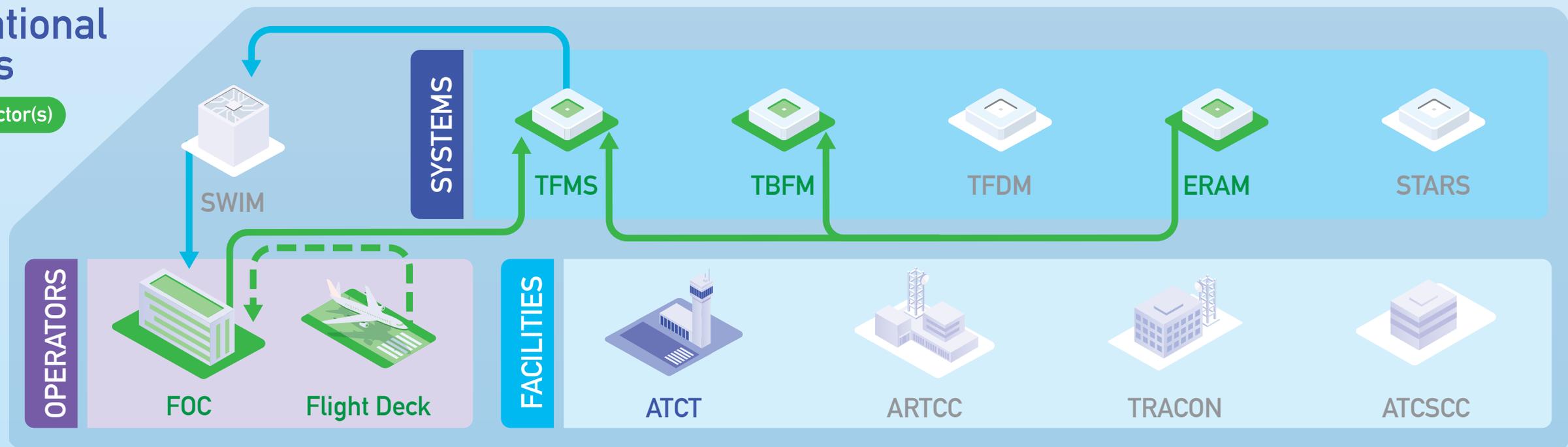
As the aircraft approaches its arrival runway and lands, radar coverage ends.

After landing, flight follows ATC instructions, and taxis to the gate.

## Operational Actors

Current Actor(s)

Step  
2/2



● **INPUTS:** →

ERAM estimates landing time based on loss of radar coverage, and send it to TFMS and TBFM.

FOC Receives On and In times from ACARS-equipped aircraft, and sends ALDT and AIBT to TFMS.

● **OUTPUTS:** →

TFMS updates ETAs and tools/displays as needed, and shares them with stakeholders.



# Initial Trajectory-Based Operations

## Decision Making and Data Flow

Additional Information on TBO capabilities, accomplishments and plans:

[https://www.faa.gov/air\\_traffic/technology/tbo/](https://www.faa.gov/air_traffic/technology/tbo/)

Additional Questions and Inquires:

[9-AJT-TBO@faa.gov](mailto:9-AJT-TBO@faa.gov)

**AAR** - Airport Arrival Rate: the number of aircraft an airport is capable of landing in an hour. This number changes based on runway configuration and local conditions.

**ABRR** - Airborne Reroute

**ACARS** - Aircraft Communications, Addressing and Reporting System

**ACM** - Adjacent Center Metering: Airborne metering conducted by a first tier ARTCC to an airport where the metering parameters are controlled by the metering ARTCC while adjacent center controllers manage aircraft in meeting their STAs in their airspace.

**AFP** - Airspace Flow Program: A Traffic Management Initiative (TMI) in which delay en route into a volume of airspace is taken on the ground (pre-departure) as a result of predicted traffic volume in that airspace. The demand is calculated and TMI parameters developed by TFMS and the Flight Schedule Monitor (FSM) capability. Taking the delay on the ground results in less fuel consumption than if the aircraft flew to the constraint point and executed en route holding. AFPs are initiated by ATCSCC in conjunction with en route facilities.

**AIBT** - Actual In-Block Time

**ALDT** - Actual Landing Time

**AOBT** - Actual Off Block Time

**ARDT** - Actual Runway Time of Departure

**ARTCC** - Air Route Traffic Control Center

**ATC** - Air Traffic Control

**ATCT** - Air Traffic Control Tower

**ATCSCC** - Air Traffic Control System Command Center

**ATM** - Air Traffic Manager

**ATOT** - Actual Take-Off Time

**CDPLC** - Controller-Pilot Data Link Communications

**CTOP** - Collaborative Trajectory Options Program

**Departure Timeline** - TBFM TGUI showing ETD at origin for ARTCC TMC situational awareness; timeline show flights departing to a specific destination or constraint point. Timeline will use p-time, or EDCT if adapted, to order flights. Scheduling on constraint timeline occurs when either Departure Scheduling is activated for the fight or flight is airborne.

**EDC** - En Route Departure Clearance: TFBM feature that enables scheduling to an adapted constraint point. This is routinely a fix on a center boundary. This includes the adapted route from major airports and enables settings to match the required downstream MIT restriction.

**EDCT** - Expected Departure Clearance Time: TFMS calculated departure time based on FSM implemented GDP or AFP.

**EOBT** - Estimated Off-Block Time

**ERAM** - En Route Automation Modernization

**ERDT** - Earliest Runway Time of Departure

**ESIS** - Enhanced Situation Information System

**ETA** - Estimated Time of Arrival: TBFM calculated time of arrival of an aircraft at a constraint point if allowed to proceed unconstrained by metering or speed control.

**ETD** - Estimated Time of Departure

**FEA** - Flow Evaluation Area: A volume of airspace designated for evaluation by Traffic Management (ARTCC or ATCSCC) for evaluation of the number of aircraft predicted to enter that airspace in a designated time period. It is used to manage demand and prevent overloading that airspace. A FEA may be used to validate MIT restriction requests or determine the need for an AFP.

**FCA** - Flow Constraint Area

**FMS** - Flight Management System

**FOC** - Flight Operations System

**FSM** - Flight Schedule Monitor- TFMS capability used to assess and manage demand and capacity to a constrained airport or airspace resource. Display employs bar graphs for demand and color coding for status of aircraft and initiatives implemented.

[Continued »](#)

**Freeze Horizon** - Point (adapted arc at a set distance from the constraint point) at which TBFM will maintain the sequence and schedule for aircraft to cross the constraint point. Freeze horizon is typically 200-500 miles from constraint point.

**FSM Bar Graph display** - Primary display used to monitor airport/airspace capacity and demand information for flights in various FSM components. (FSM also has a timeline display to show how flights are distributed throughout each hour)

**GDP** - Ground Delay Program: A Traffic Management Initiative (TMI) in which delay en route to an airport is taken on the ground (pre-departure) as a result of predicted arrival demand at the airport. The demand is calculated and TMI parameters developed by TFMS and the Flight Schedule Monitor (FSM) capability. Taking the delay on the ground results in less fuel consumption than if the aircraft flew to the constraint point and executed en route holding. GDPs are initiated by ATCCSCC in conjunction with en route and terminal facilities.

**IDAC** - Integrated Departure/Arrival Capability

**MAP** - Monitor Alert Parameter: a negotiated value equal to the number of aircraft in a sector at which the Operations Supervisor must be notified of the traffic volume.

**MIT** - Miles in Trail: A manual distance-based traffic management technique based on relative spacing between aircraft. It is monitored and maintained by controller action and has no time-based reference.

**NTML** - National Traffic Management Log: An FAA operational position log used to communicate between all FAA facilities by providing single point of entry, automated data collection and real time distribution of operational data across TFMS.

**NTMO** - National Traffic Management Officer

**OAG** - Official Airline Guide: OAG is a global travel data provider with a large network of flight information data including schedules, flight status, connection times and industry reference codes. It is the industry standard and primary source of long-range flight planning information for TFMS.

**OIS** - Operational Information System: The OIS system is a web-based application that displays up to the minute Ground Delay, Ground Stop, Deicing, and general airport delay information.

**PBN** - Performance-Based Navigation

**P-time** - Proposed time of departure: Flight plan field indicating operator's proposed gate departure time.

**RNP** - Required Navigation Performance

**RRIA** - Reroute Impact Assessment

**STA** - Scheduled Time of Arrival: TBFM calculated aircraft arrival time at adapted constraint point.

**STARS** - Standard Terminal Automation Replacement System

**STD** - Scheduled Time of Departure: TBFM calculated aircraft departure time to meet downstream constraint.

**SWIM** - System Wide Information Management

**TBM** - Time-Based Management: Traffic flow management technique that uses time as a common reference for managing aircraft operations.

**TDFM** - Terminal Data Flight Manager

**TBFM** - Time-Based Flow Management

**TFMS** - Time Flow Management System

**TMAT** - Target Movement Area Time

**TMC** - Traffic Management Coordinator

**TMI** - Traffic Management Initiative

**TRACON** - Terminal Radar Approach Control Facility

**TOBT** - Target Off Block Time

**TOS** - Trajectory Options Set

**TSAS** - Terminal Sequencing and Spacing

**XM** - Extended Metering: An extension of arrival metering that increases the distance of scheduling arrivals to an airport. XM adds an additional segment of metered operation to a constraint point and delivers a metered flow to the arrival metering sector(s) to further enhance the smooth and orderly flow to the airport.