



# Trajectory Based Operations and Verification and Validation

V&V Summit September 2017



**FAA**

# Trajectory Based Operations (TBO)

*...an Air Traffic Management (ATM) method for strategically planning, managing, and optimizing flights throughout the operation by using time-based management, information exchange between air and ground systems, and the aircraft's ability to fly precise paths in time and space.*



# Path to Trajectory Based Operations

2020

2020

2025

## Full TBO

### Time Based Management and PBN Integrated at Single Locations

- Performance Based Navigation (PBN) at nine metroplex sites
- Automatic Dependent Surveillance – Broadcast (ADS-B) Out mandate
- Initial Data Communications (tower and En Route)
- Improved weather impact information
- Collaborative information sharing

2025

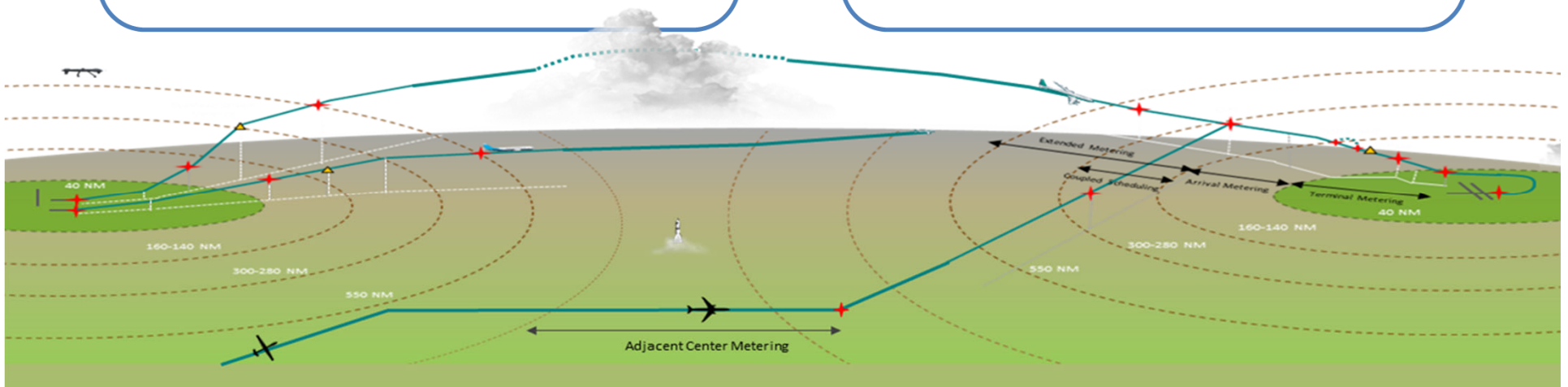
2025

2030

## Dynamic TBO

### Time Based Management and PBN Integrated Across Locations

- Increased use of PBN procedures
- Aircraft equipage alignment with new standards
- Data Communications full capability
- Integrated weather with decision making
- Integrated arrival and departure scheduling
- Trajectory Based collaborative decision making



# Path to TBO

## High-Level Capabilities Maturity Timeline

### Time Based Flow Management

#### Traffic Management Advisor (TMA)

ATM tool that seeks to schedule aircraft to the runway threshold with the least amount of delay.

#### Coupled Scheduling

TMA with additional metering points further out from the airport to allow for more optimal balancing of traffic demand

#### Extended Metering

create additional metering points over an extended distances for the arrival stream. Allocate delay further upstream prior to the Top of Descent

#### Departure Scheduling into Overhead Stream (IDAC)

coordinates the departure times between airports and provides situational awareness to Air Traffic Control Towers (ATCT) so that they can select from available departure times and plan their operation to meet these times

#### \*\*Terminal Metering on Arrival (TSAS)

ground based system that combines time based metering and controller precision spacing tool in the terminal area

### Surface Operations

#### Surface Visualization Tool

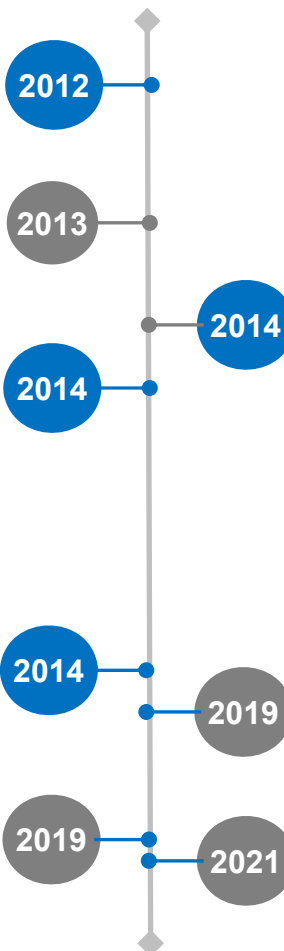
provides real time airport surface traffic picture

#### \*\*Electronic Flight Strips

replace printed flight strips in the tower

#### \*\*Surface Sequencing and Metering

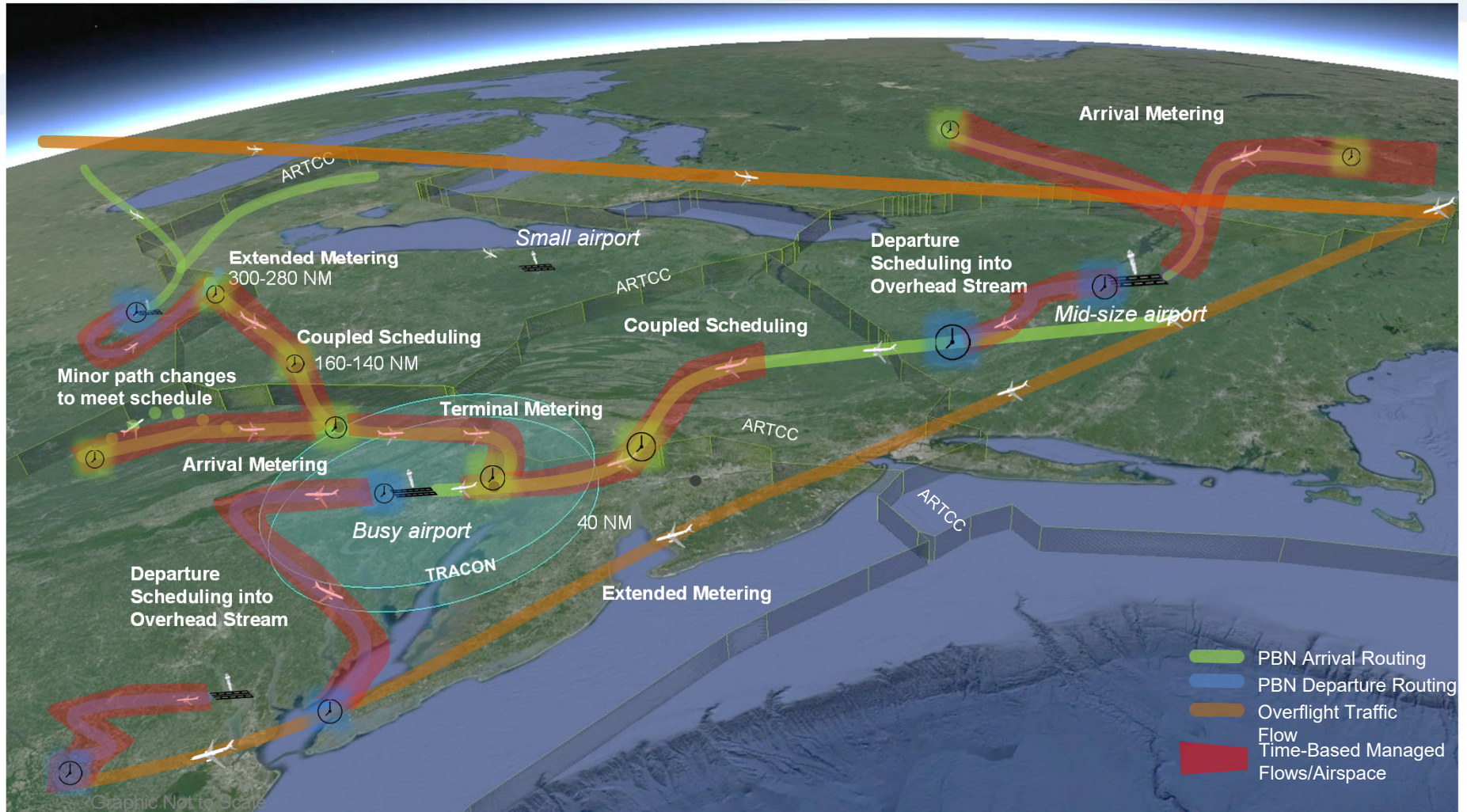
in collaboration with operators, sequence and meter traffic on the surface to reduce surface congestion.



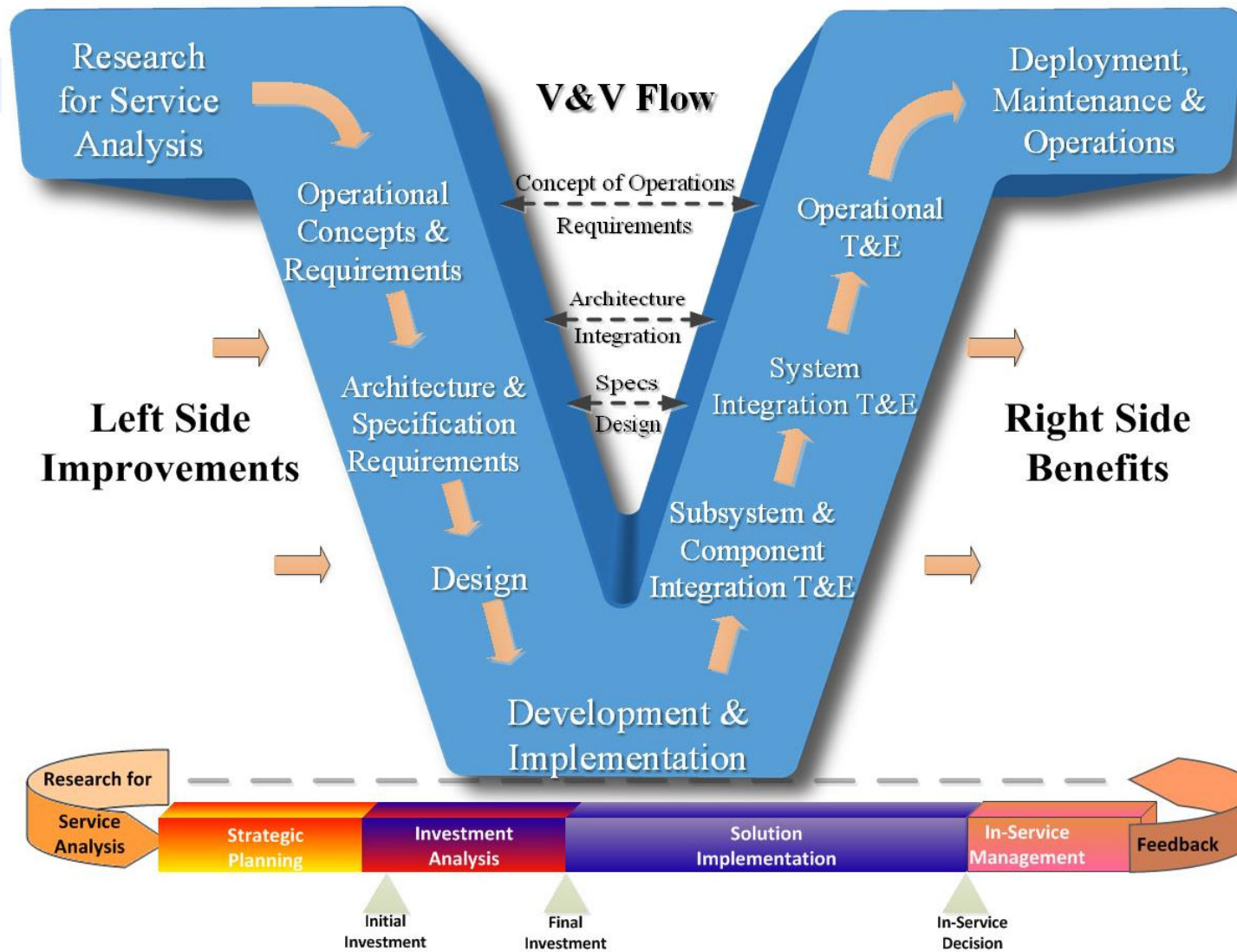
\*\*Future Capabilities



# TBO: Efficiency, Predictability and Flexibility



# Verification & Validation



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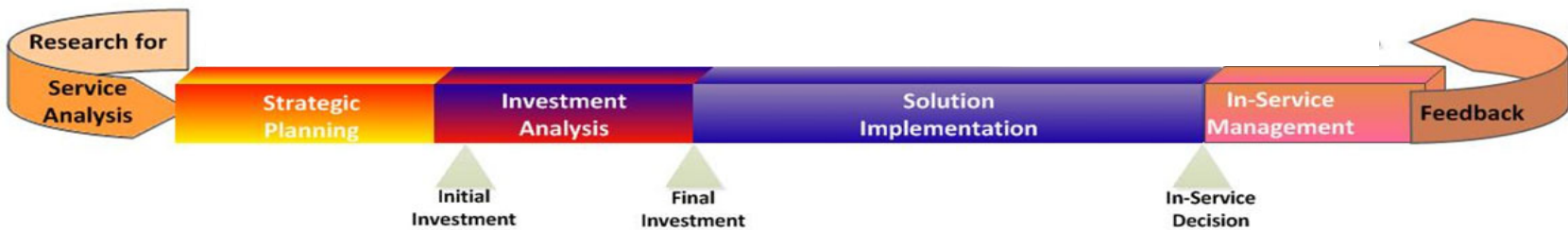
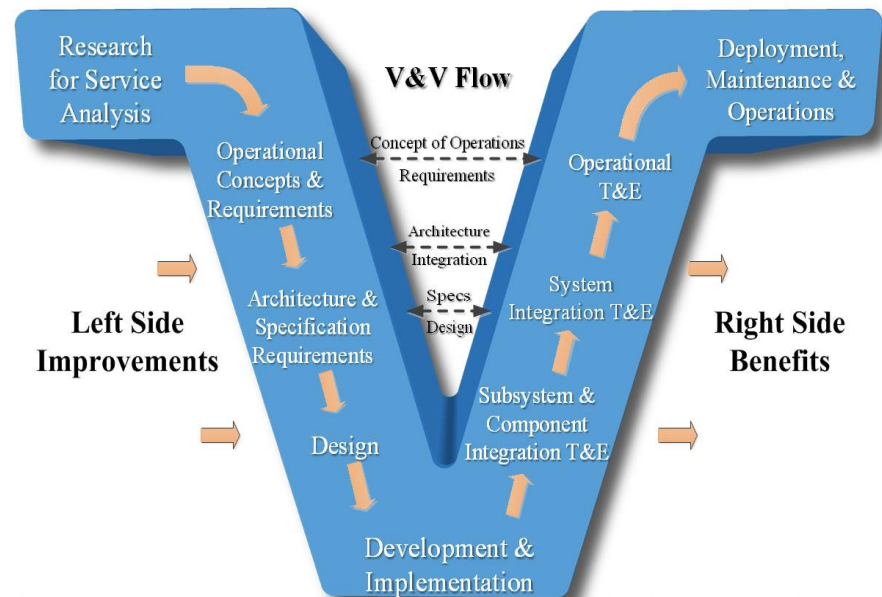
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# V&V Process (Left Side Focused)

(Research for Service Analysis ~ Strategic Planning ~ Investment Analysis)

## Typical Activities

- ✦ Concept of Use
- ✦ Operational Scenarios
- ✦ Use Cases
- ✦ Simulation and Modeling
- ✦ Integrated Demonstrations
- ✦ Acquisition Documentation
- ✦ Requirements



# Today's Challenge

## Verification & Validation of Integrated Capabilities

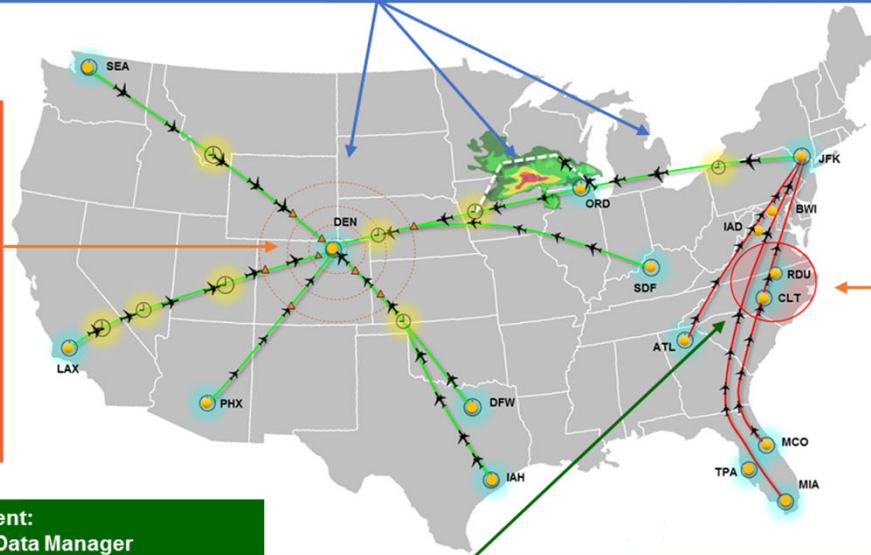
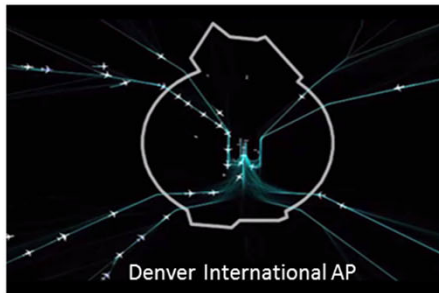
### Strategic Flow: Traffic Flow Management System

Provides a strategic view of the NAS used for planning and mitigation of demand – capacity imbalances



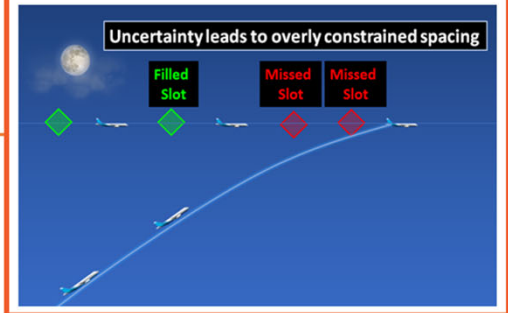
### Tactical Flow: Time Based Flow Management

#### Time Based Arrival Management



### Tactical Flow: Time Based Flow Management

#### Time Based Departure Management

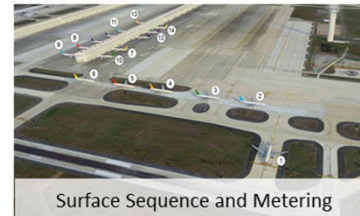
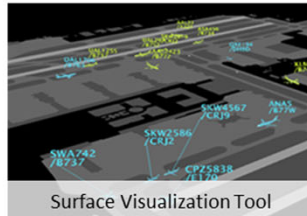


### Surface Movement: Terminal Flight Data Manager

#### Time Based Surface Management

Electronic Flight Strips

Flight Number	Altitude	Speed	Heading	Altitude	Speed	Heading	Altitude	Speed	Heading
SWA742	78737								
SWW2586	7CR12								
SWW5167	7CR19								
CP75938	71728								



ARTCC – Air Route Traffic Control Center

TRACON – Terminal Radar Approach Control



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# The Human is Key in Transition to TBO



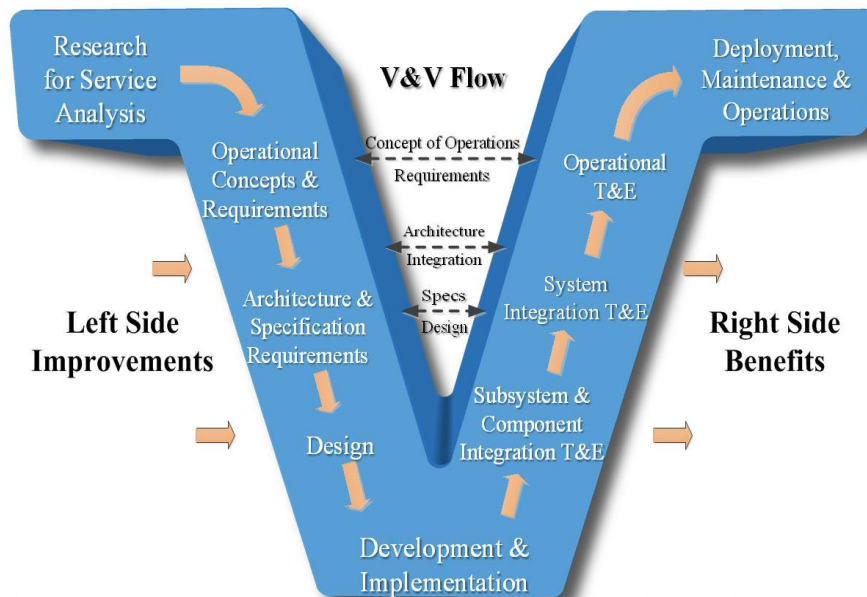
Evolution of Workforce Skillsets:  
Shift to Time-Based Management  
while Maintaining Proficiency in  
Conventional Techniques

Human-Centric and Holistic Approach  
to Implementation and Training  
Communicating Team Perspective  
Formulating Regional Solutions



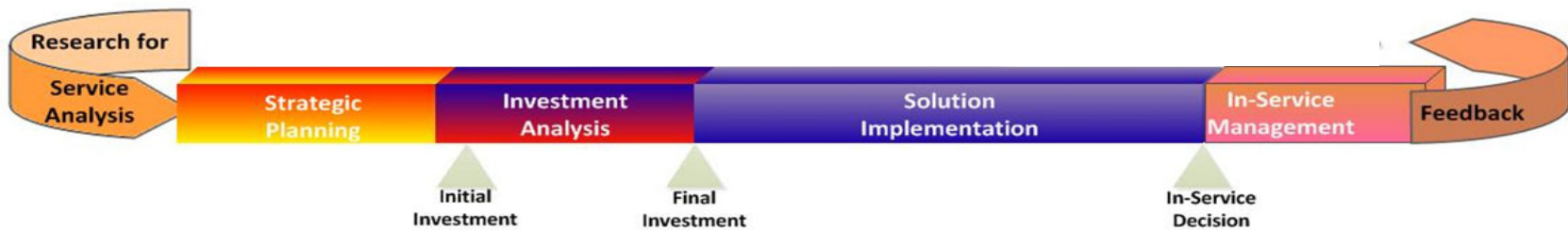
# V&V Process (Right Side Focused)

(Solution Implementation ~ In-Service Management ~ Feedback)



## Test and Evaluation (T&E) *Pulling It All Together*

- ★ Today's Challenge
  - Human Integration
  - Systems-of-Systems Integration





# Thank You



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