Summit Introduction

Federal Aviation Administration

13th Annual

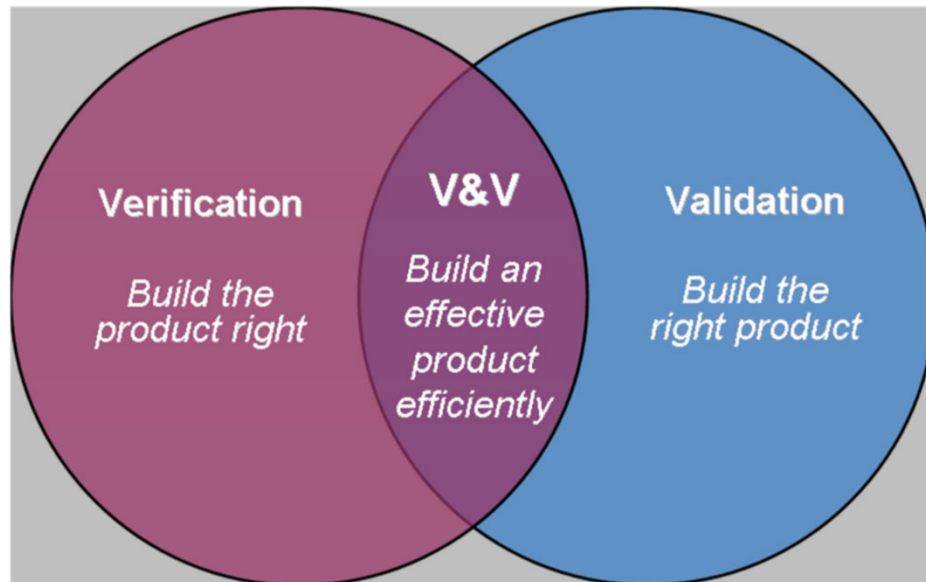# Verification & Validation Summit

"Systems Thinking – Thinking"

Presented by: John Frederick

What is V&V?

Verification – **Ensures that selected work products meet their specified requirements**

Validation – **Demonstrates whether a product will fulfill its specified purpose when placed in its intended environment**

Note: V&V is broader than Test and Evaluation (T&E). The performance of T&E supports the goals and objectives of V&V.
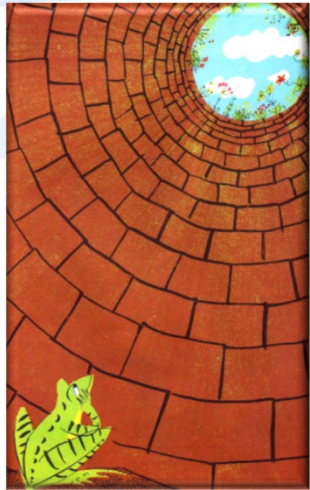
V&V "Fun" Fact

Verification – derived from the Latin word, veritas, meaning <u>TRUTH</u>

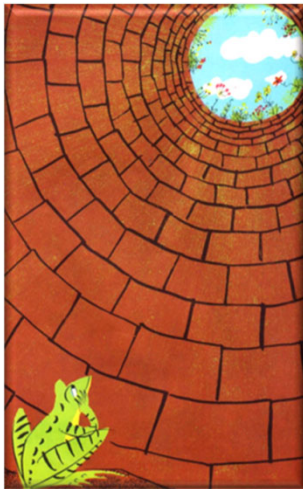*Validation – derived from the Latin word, valere, meaning <u>WORTH</u>*

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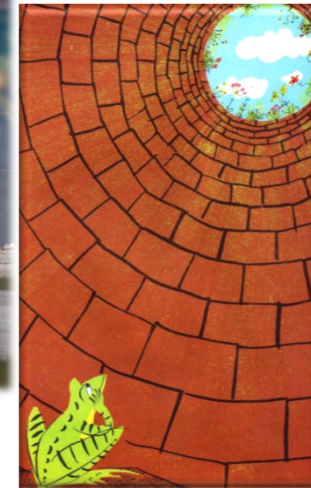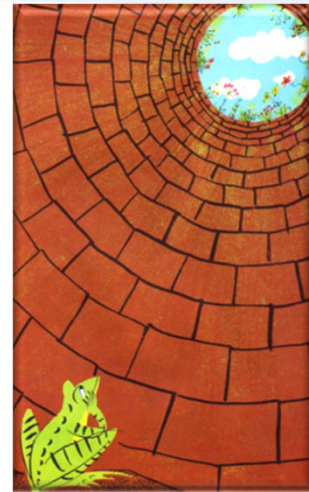# For Complex System-of-Systems we Need to Think Beyond a Single System or Service

Service D…

Service A

System C

System B

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What is Systems Thinking?

➢ **A way of thinking** – used to address complex and uncertain real world problems. It recognizes that the world is a set of highly interconnected technical and social entities which are hierarchically organized producing <u>emergent behavior</u>

➢ **A framework** – for seeing <u>interrelationships</u> rather than things, for seeing <u>patterns</u> rather than static snapshots. It is a set of general principles <u>spanning fields</u> as diverse as physical and social sciences, engineering and management [Peter Senge, The Fifth Discipline]

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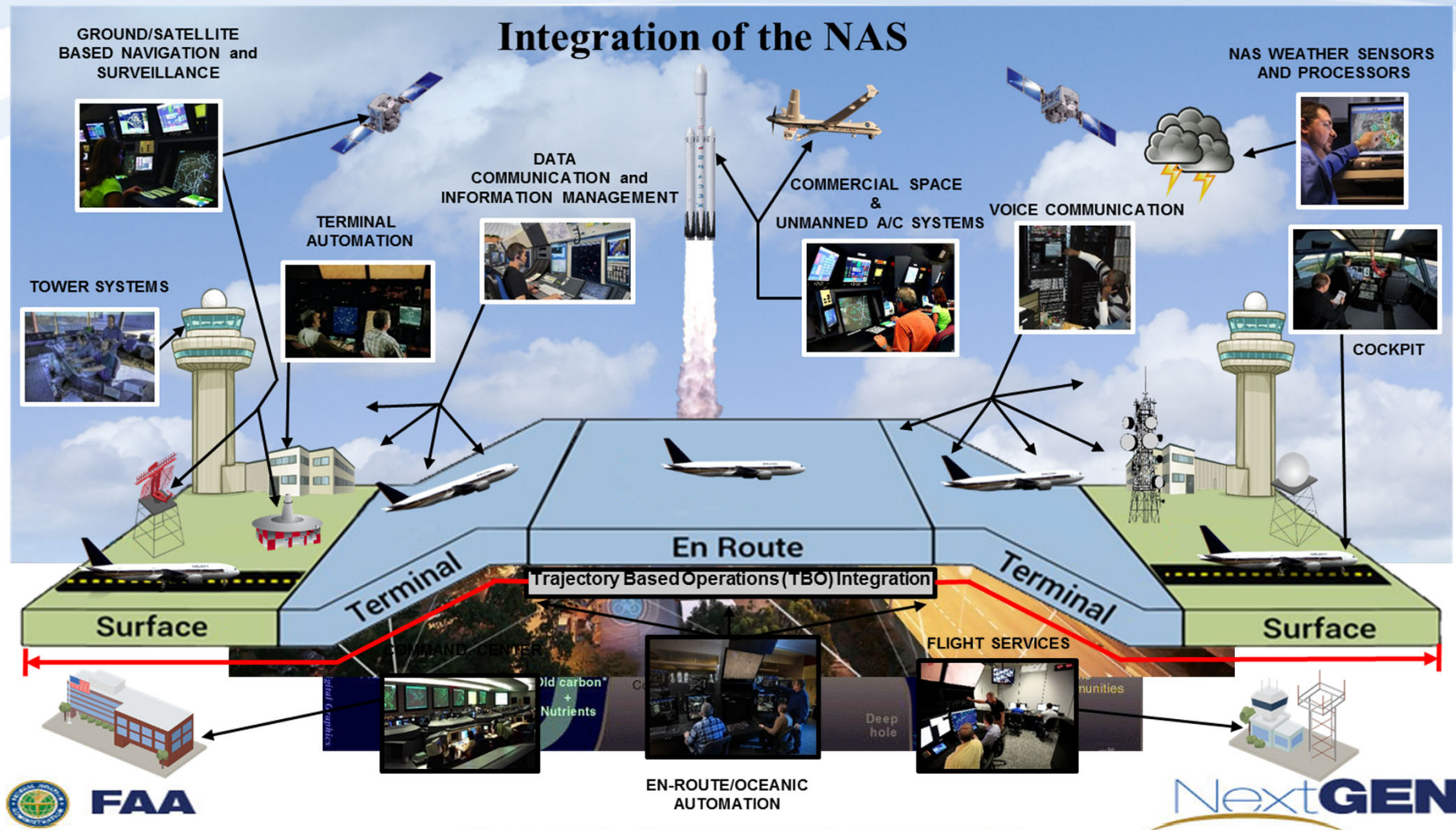NextGEN

Benefits of Systems Thinking

- **Optimization:** deeper understanding
- **Problem Loving:** problems offer opportunities for innovation
- **"Failure is Fun":** failure helps gain new perspectives that build creative capacity
- **3-Dimensional Perspective:** holistic view
- **From Linear to Circular:** feedbacks and regenerative
- **Interconnectivity:** everything is dynamically interconnected and interdependent
- **Creativity:** enables dynamic, divergent thinking

Systematic V&V Enables and Supports Systems Thinking

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Synthesis of Interactions

Integration of the NAS

GROUND/SATELLITE BASED NAVIGATION and SURVEILLANCE

NAS WEATHER SENSORS AND PROCESSORS

DATA COMMUNICATION and INFORMATION MANAGEMENT

COMMERCIAL SPACE & UNMANNED A/C SYSTEMS

VOICE COMMUNICATION

TERMINAL AUTOMATION

TOWER SYSTEMS

COCKPIT

En Route

Terminal

Terminal

Trajectory Based Operations (TBO) Integration

Surface

Surface

FLIGHT SERVICES

EN-ROUTE/OCEANIC AUTOMATION

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Without Systems Thinking: Effectiveness Impacts
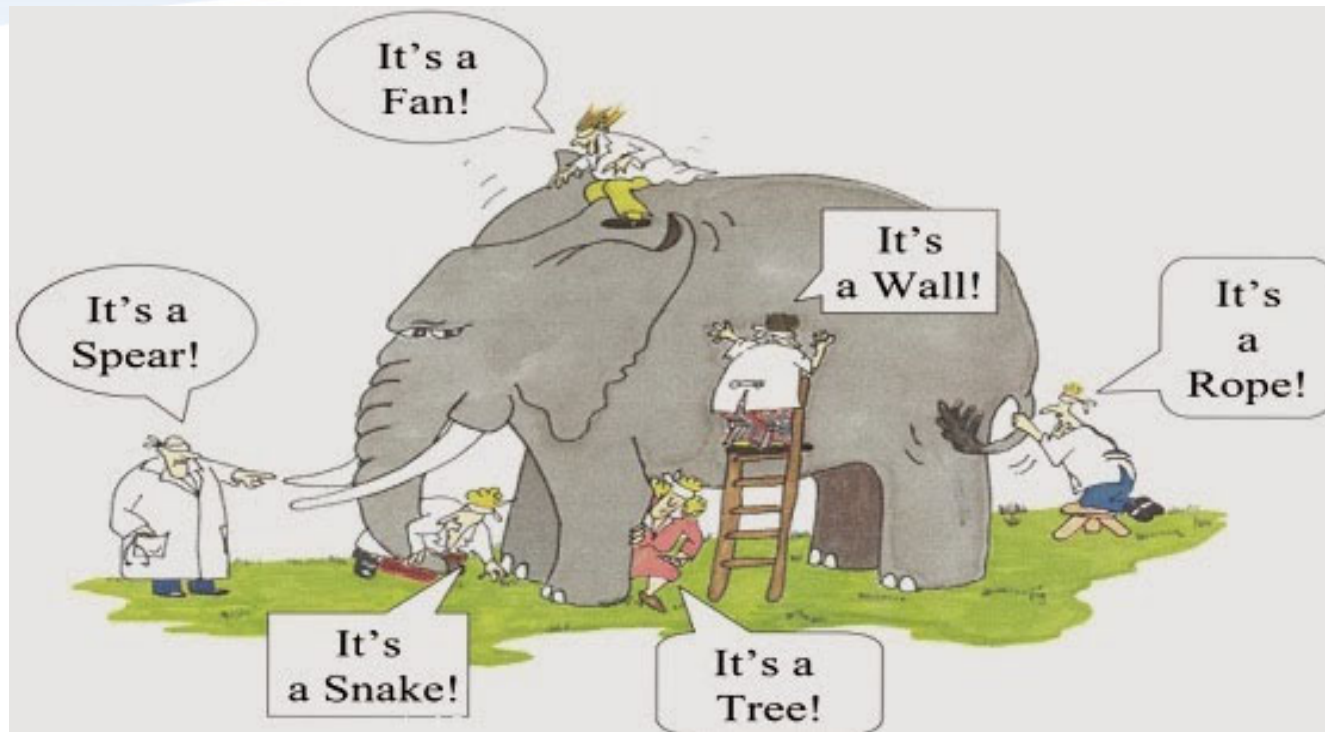
Without Systems Thinking: Efficiency Impacts

Whack-a-Mole Systems Integration

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Stoic Virtues of Systems Thinking

➢ **A Life According to Nature and Being Mindful**

➢ **The Stoics holistically apply three usually distinct fields of study:**

   ➢ Logic – reasoning

   ➢ Physics – understanding of reality

   ➢ Ethics – doing the right thing/the crucial task of living well

➢ **Turn Obstacles into Opportunities – Perception Is Key**

➢ **You are part of a Greater Whole – Mutual interdependence**

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Famous Stoics

➢ Seneca the Younger: 4 BC – 65 AD

➢ Marcus Aurelius: 121 – 180 AD →

➢ George Washington: 1732 – 1799

➢ Thomas Jefferson: 1743 – 1826

➢ Theodore Roosevelt: 1858 – 1919

➢ Frederick the Great: 1712 – 1786 →

  (King of Prussia)

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Systems Thinking – Thinking: Take-a-Way Goals

- Systems Thinking is a discipline (like Stoicism and V&V)
  - Not human nature
  - Requires us to be mindful
- Embrace problems and recognize opportunities
  - Accept and learn from failure (don't conceal)
  - Innovate and promote creativity
- Seek Interconnectivity
- Systems Thinking is not just technical - It spans many fields
- Change your perspective to understand
  - Get out of the well for a holistic view

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