
Source: US DOT

# Technology Exploration and Implementation: Keys to Success

*CTAA EXPO 2017: Manage Track*

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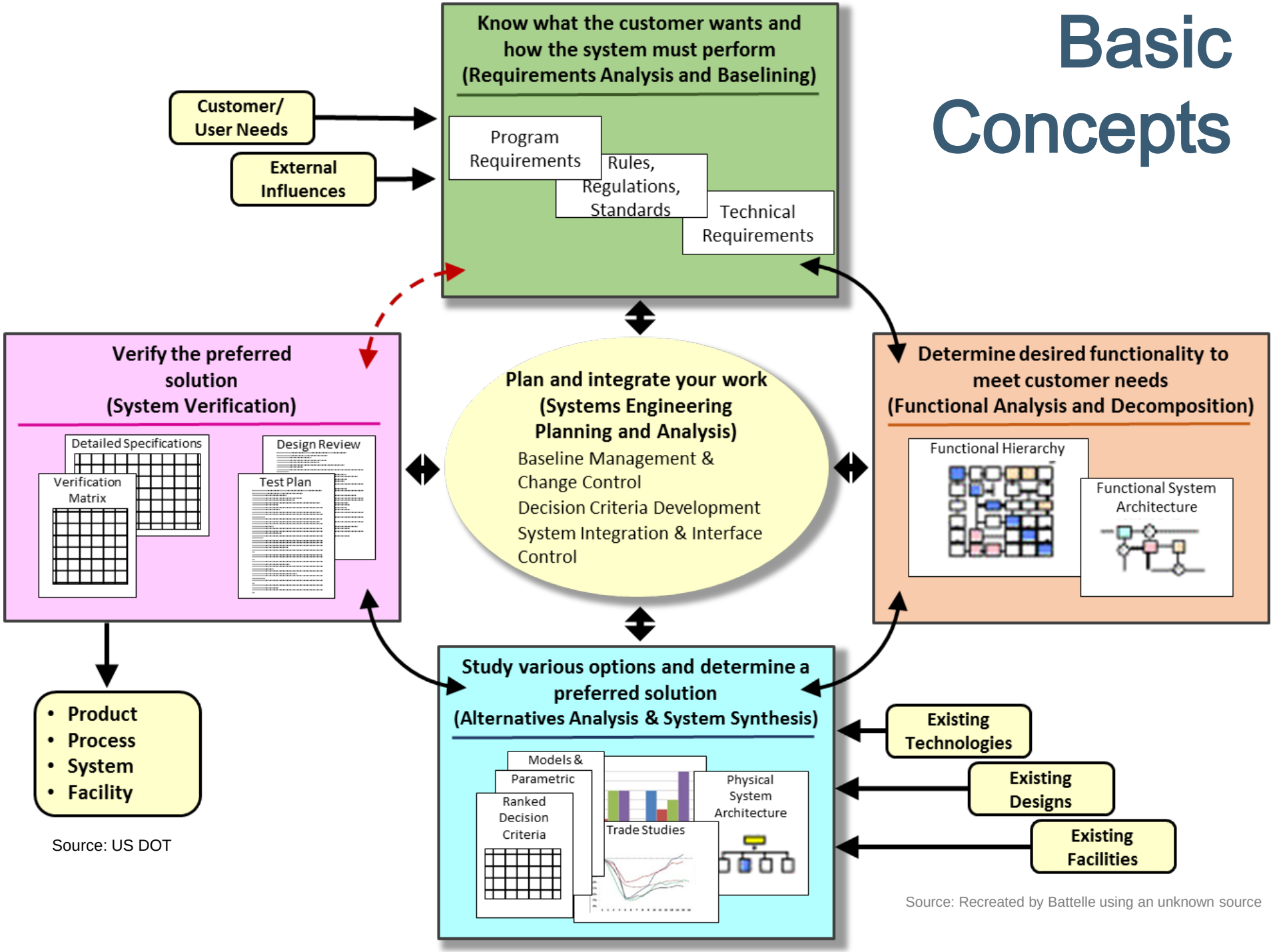
# Presentation Outline

- Basic Principles of Structured Design Approach
- Identifying Needs
- Developing Requirements
- Procuring System
- Implementing System


Source: US DOT

# Basic Concepts




Source: US DOT

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# What is a Structured Approach?

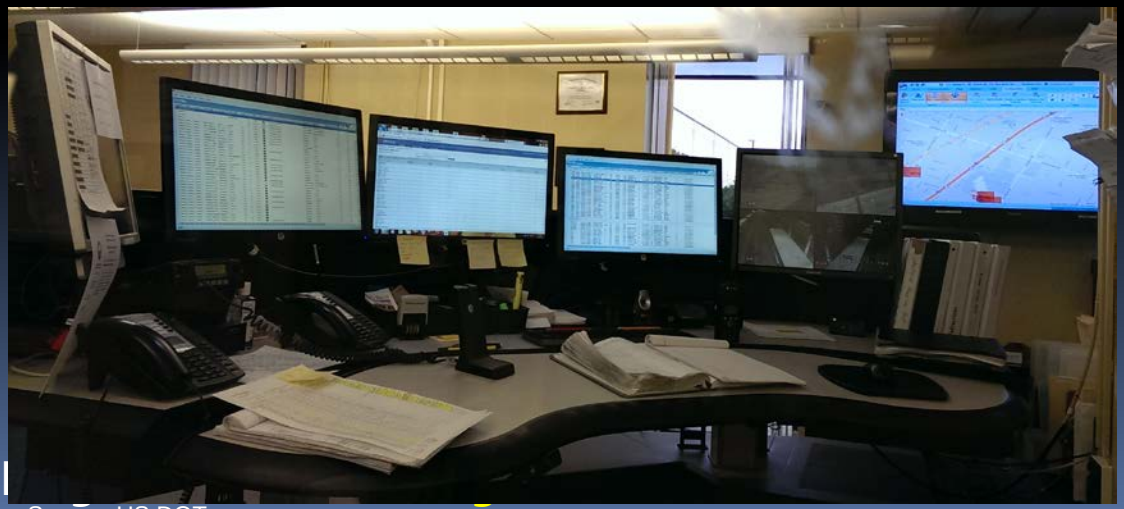
- **Interdisciplinary** approach
- Focuses on defining **customer needs** and required functionality
- Final design selected from **alternatives that accomplish objectives** and considers technical merits and costs
- Addresses the problem **throughout the process**

# Structured Approach Allows You To:

- Define and manage **system requirements**
- Identify and minimize **risk**
- **Integrate** system components (physical and organizational)
- **Manage** system complexity
- Enhance communication and system **understanding**
- **Verify** products and services meet customer needs
- **Scale** your process to size and complexity of the project

# High Level Considerations

- How well did the system satisfy the needs of the stakeholders?
- Did the project stay within the budgeted cost and schedule?
- What types of challenges occurred during technology implementation?



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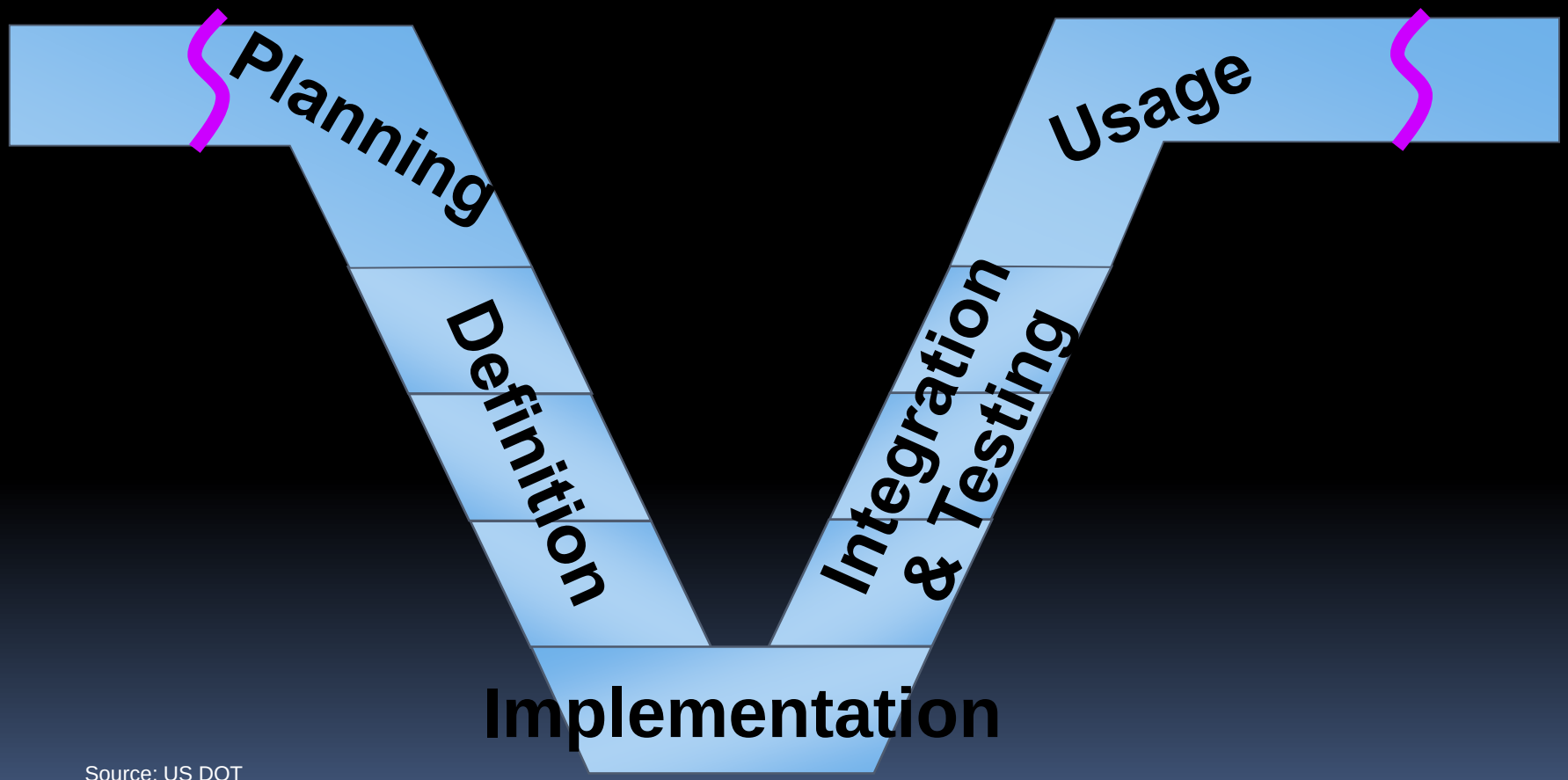
# High-Level "V" Diagram

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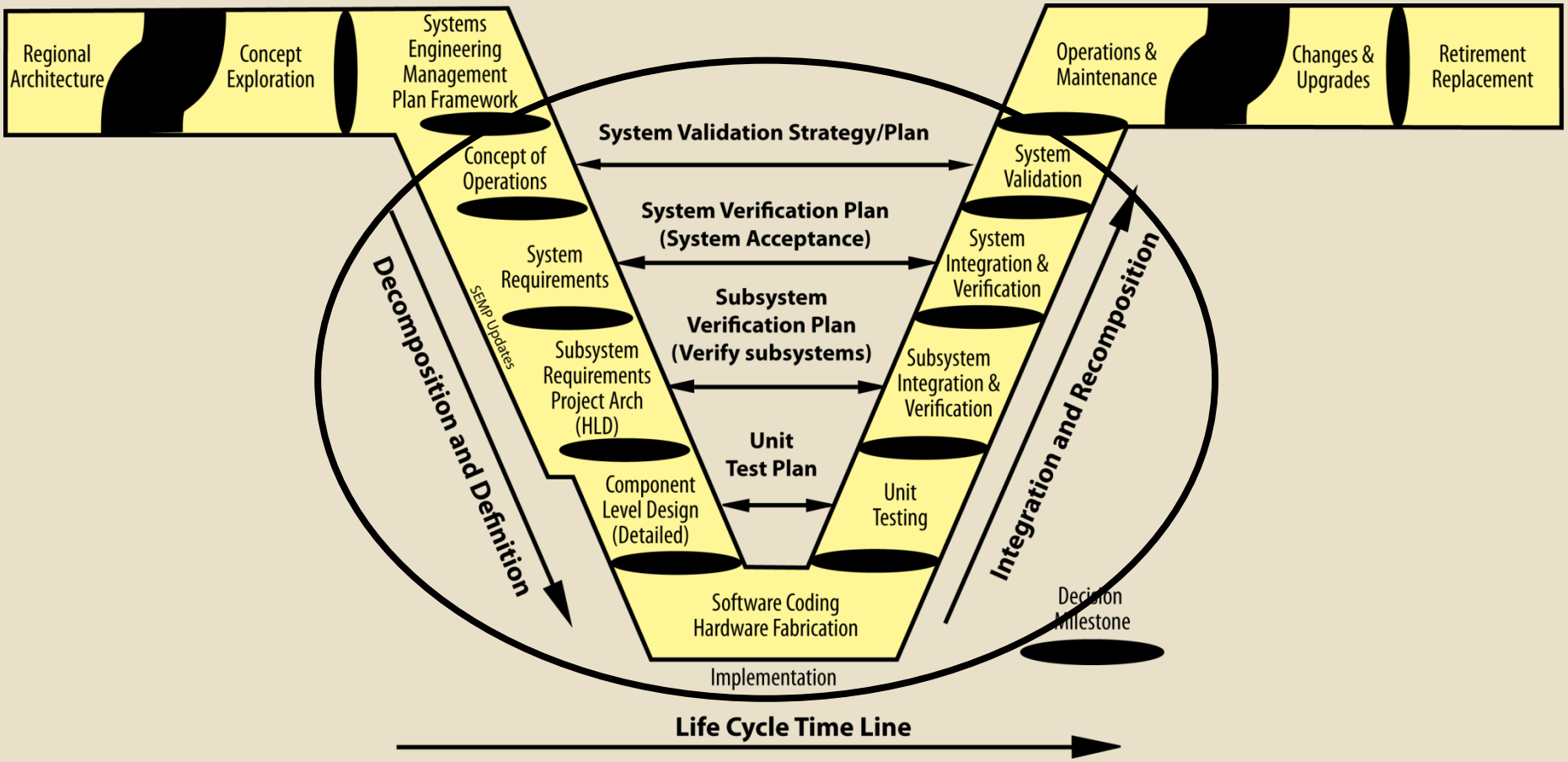
# Detailed V Diagram

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- V symmetry reflects the relationship between the steps on the left and right
- Definition generated on the left is ultimately used to verify the system on right

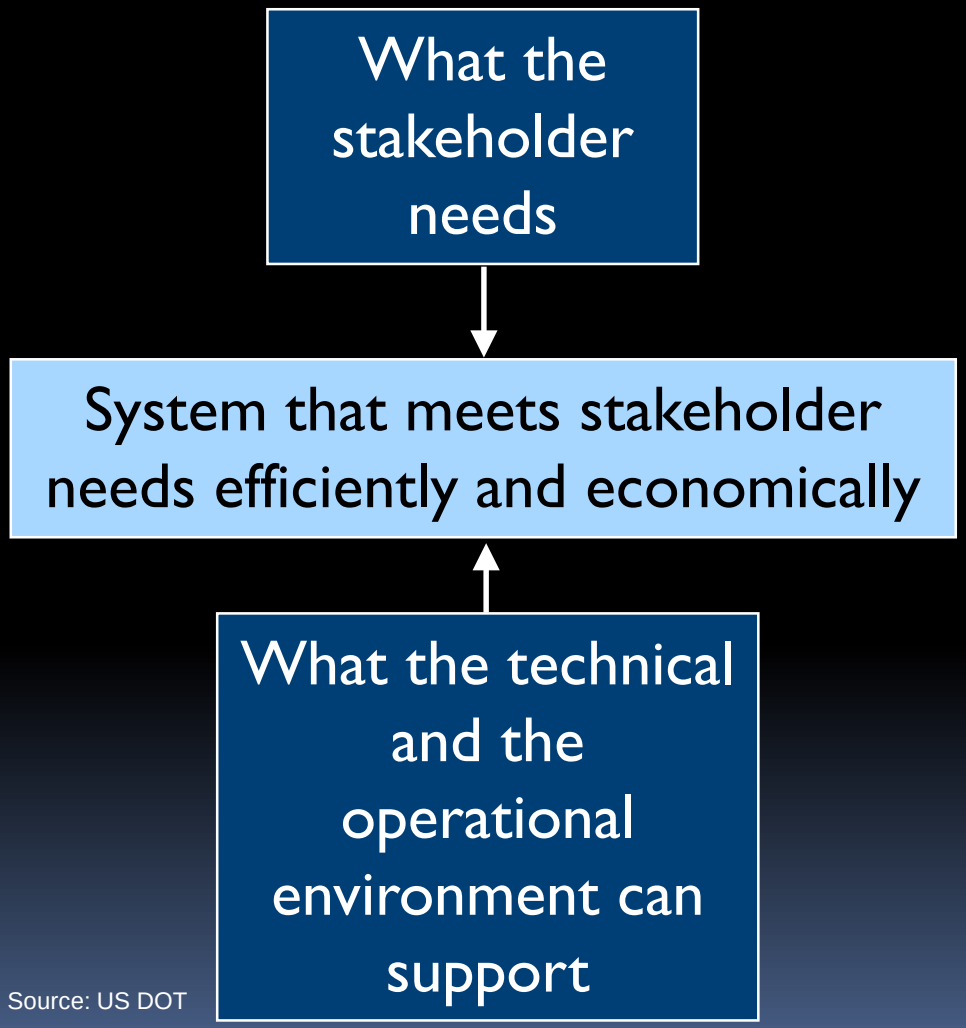
# Technology Improves Human Service Transportation

- Directly **address and overcome** unmet mobility needs
- Solve problems related to:
  - **Service** availability and information/knowledge
  - **System** accessibility, reliability, safety and flexibility
- Generate significant efficiency and service quality benefits by:
  - Facilitating **coordination**
  - **Integrating** disparate systems
  - Provide greater **visibility** and situational awareness of:
    - Travelers
    - Agency vehicles

# Planning-Design-Implementation Process

1. Understand technologies
2. Identify user needs and external factors influencing technology deployment
3. Determine functionality required to meet users' needs
4. Study system alternatives and determine preferred solution
5. Verify solution using rigorous process that ensures that solution meets user needs and functional requirements

# Structured Approach 101

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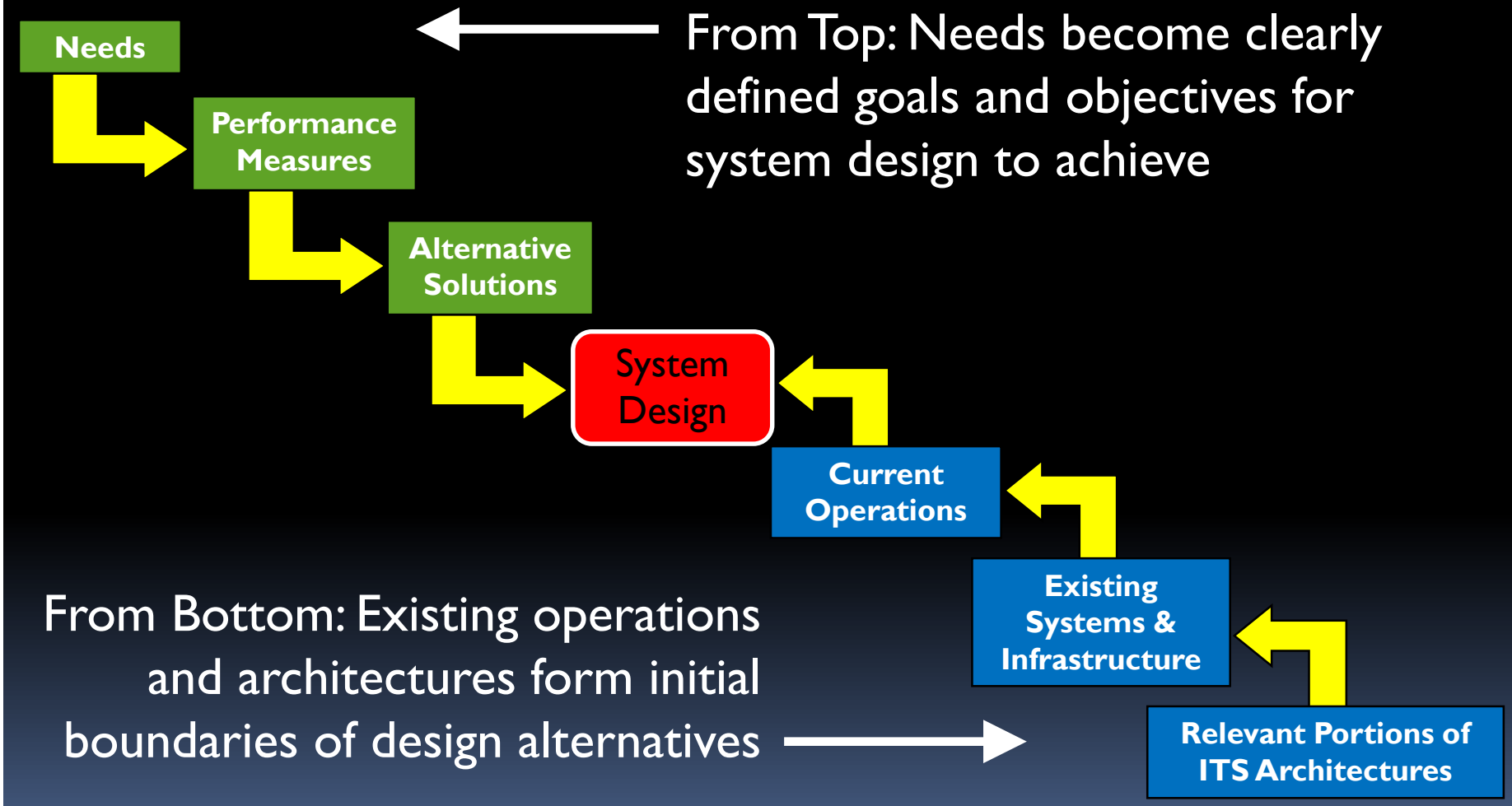
# Structured Approach 101 (cont'd)

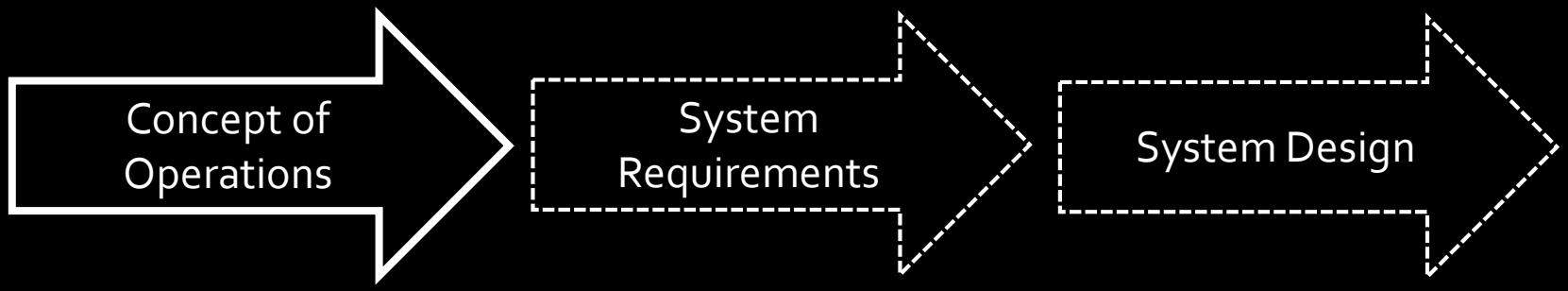



From Top: Needs become clearly defined goals and objectives for system design to achieve

From Bottom: Existing operations and architectures form initial boundaries of design alternatives

Source: US DOT

# Identify Needs




- **User needs**
- Expectations
- Goals
- Objectives
- System operation

- Complete
- Verifiable
- Validated
- Review/approval
- Traceability

- Develop/evaluate alternatives
- Identify connections
- Consider standards
- Preliminary design review

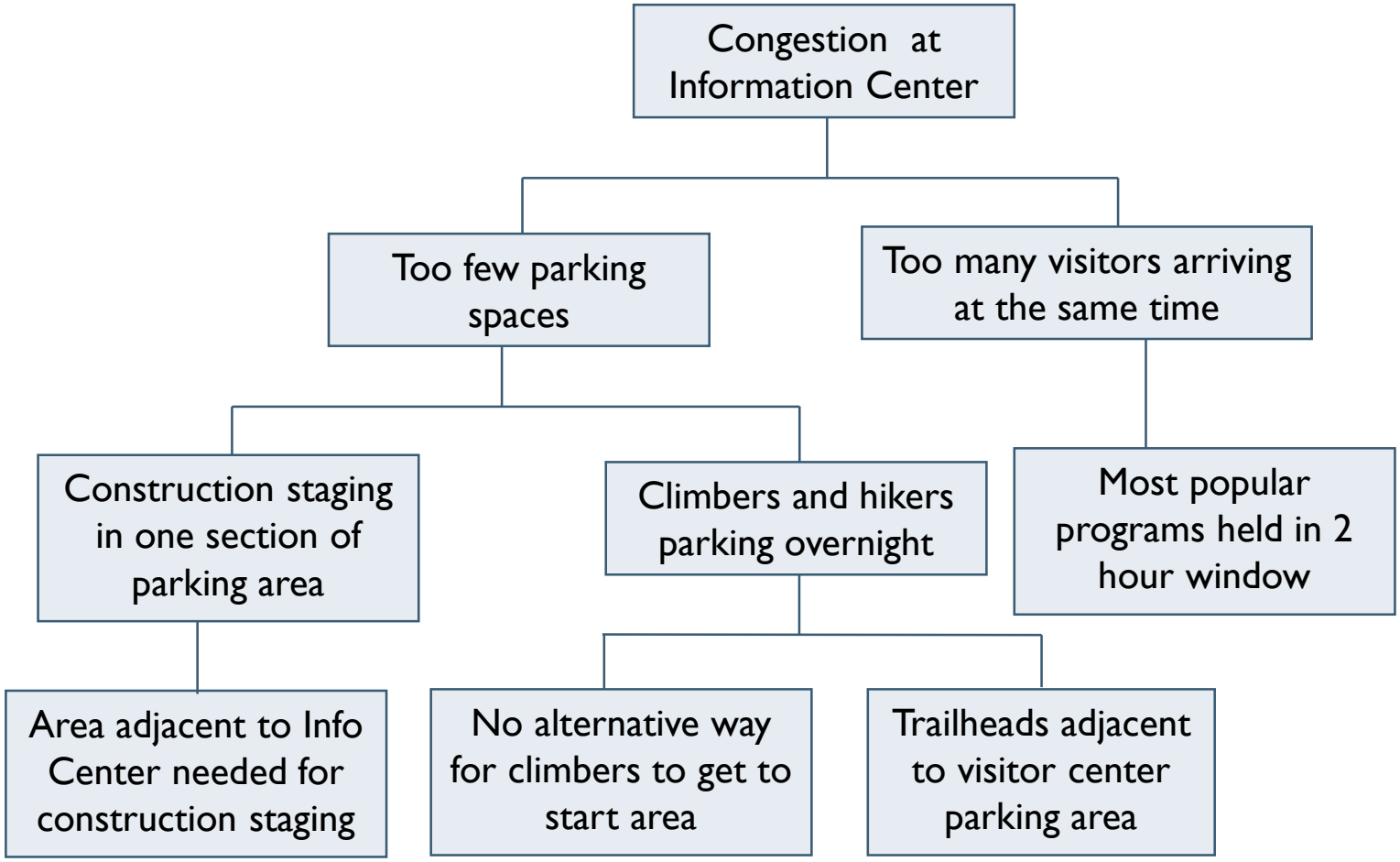
Source: US DOT

# What is a Need?

- Problem to be solved
- Process to be improved
- New capability
- Needs are translated into goal(s), requisite objective(s) and ultimately into requirements


Source: US DOT

# Define the Problem




Problem

↓

Cause

↓

Cause

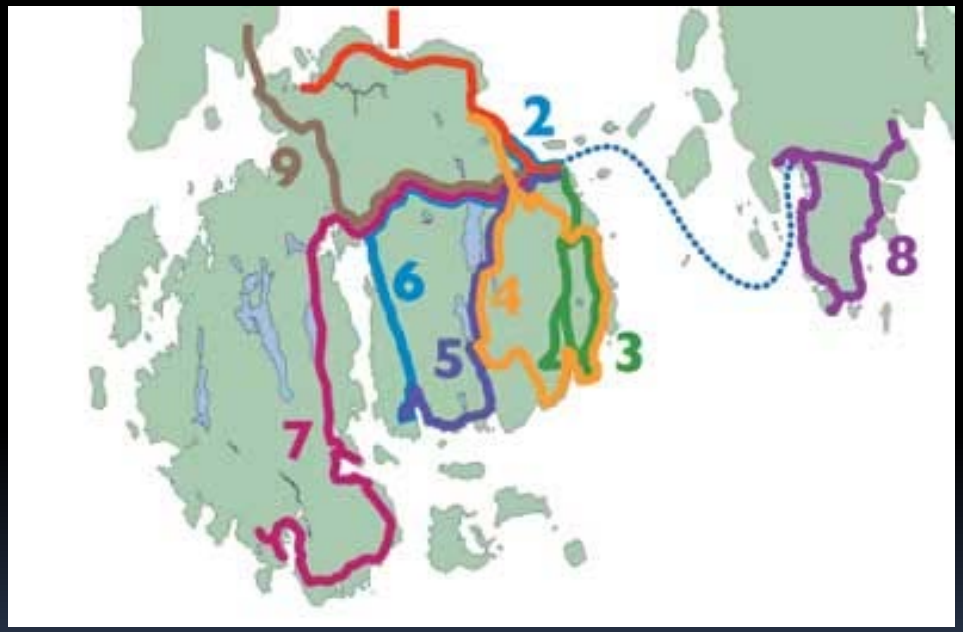
↓

Cause

Source: US DOT

# Identify Needs (cont'd)

- Windshield Tourists
- Meadow walkers
- Half-day hikers
- All-day hikers
- Overnight campers
- Technical climbers
- In-Park lodgers
- Nearby lodgers




Source: US DOT

# Identify Needs (cont'd)

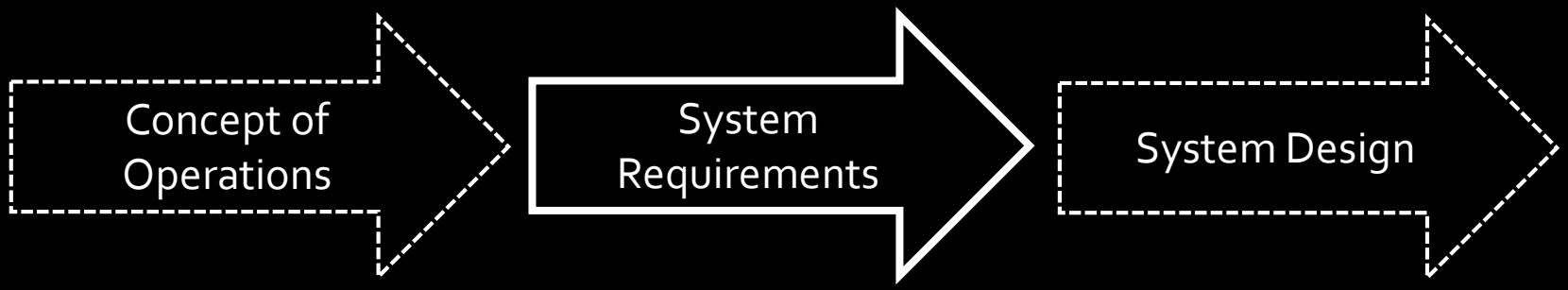
- User groups may represent distinct demographics that will affect **how they interact** with the system:
  - Technical climbers may be more likely to access using web-based approach
  - Windshield tourists may be more comfortable using the phone/may not have access to web


Source: US DOT

# Identify Needs (concluded)

- Operators may be constrained by contract rules:
  - Example: Transit operators may be working under contracts with specific rules governing what they do – will your new system be covered under their work rules?
- Once problem identified, develop goals and objectives to address it

# Mapping Needs to Requirements

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# Requirements

- **Functional** – what system does
  - Example – "The system shall provide information on the number of riders on each bus route, by time of day, in one hour increments."
- **Performance** – how well
  - Example – "The system shall process simultaneous data inputs from up to 10,000 individual sensors, providing operator feedback with 0.5 seconds of signal receipt."

# Requirements (continued)

- **Environmental/non-functional** – under what conditions
  - Example – “The fare collection equipment shall operate when installed on buses with normal voltage of +12 volts and within a voltage range of +10 to +18 volts”
- **Enabling** – necessary, but not part of the system
  - Training courses shall be provided on all facilities, systems, equipment, hardware, firmware, software, and pertinent interfaces developed for the project
  - Tests shall be performed for all equipment and materials developed for the project

# Considerations for Writing Requirements

- Document critical information and assumptions –link to requirement as it works its way through the development cycle
- Address “what” instead of “how”
- Should not describe operations
- Avoid over-specifying

# Requirements Validation

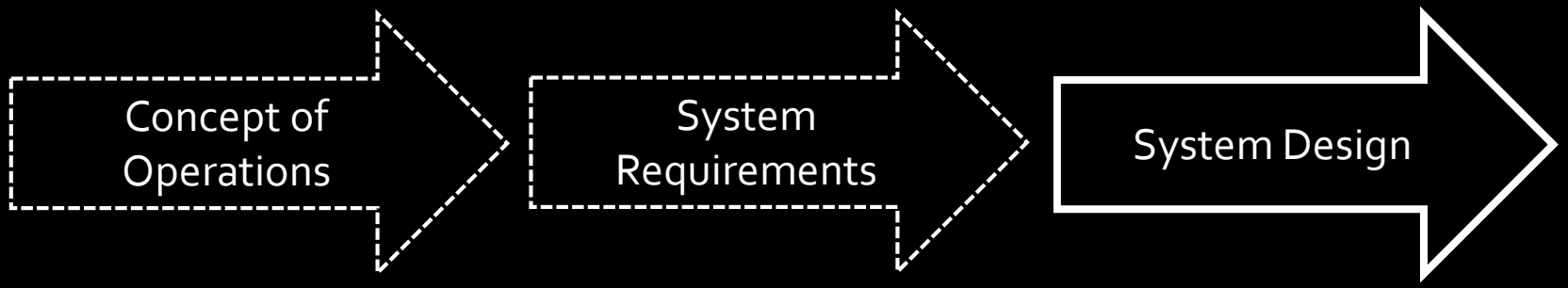
- Check for consistency, accuracy, completeness
- Identify requirement defects as early as possible
- Use “walkthroughs”
  - Review requirements in a systematic way with project stakeholders and project team

# Traceability – A Management Tool

Each requirement should trace to:

- Higher-level requirement
- Previously provided stakeholder need
- Other governing rules, standards, or constraints
- Test case that will verify it
- More detailed “child” requirements
- Design elements that will help implement it

# Mapping Requirements to Design

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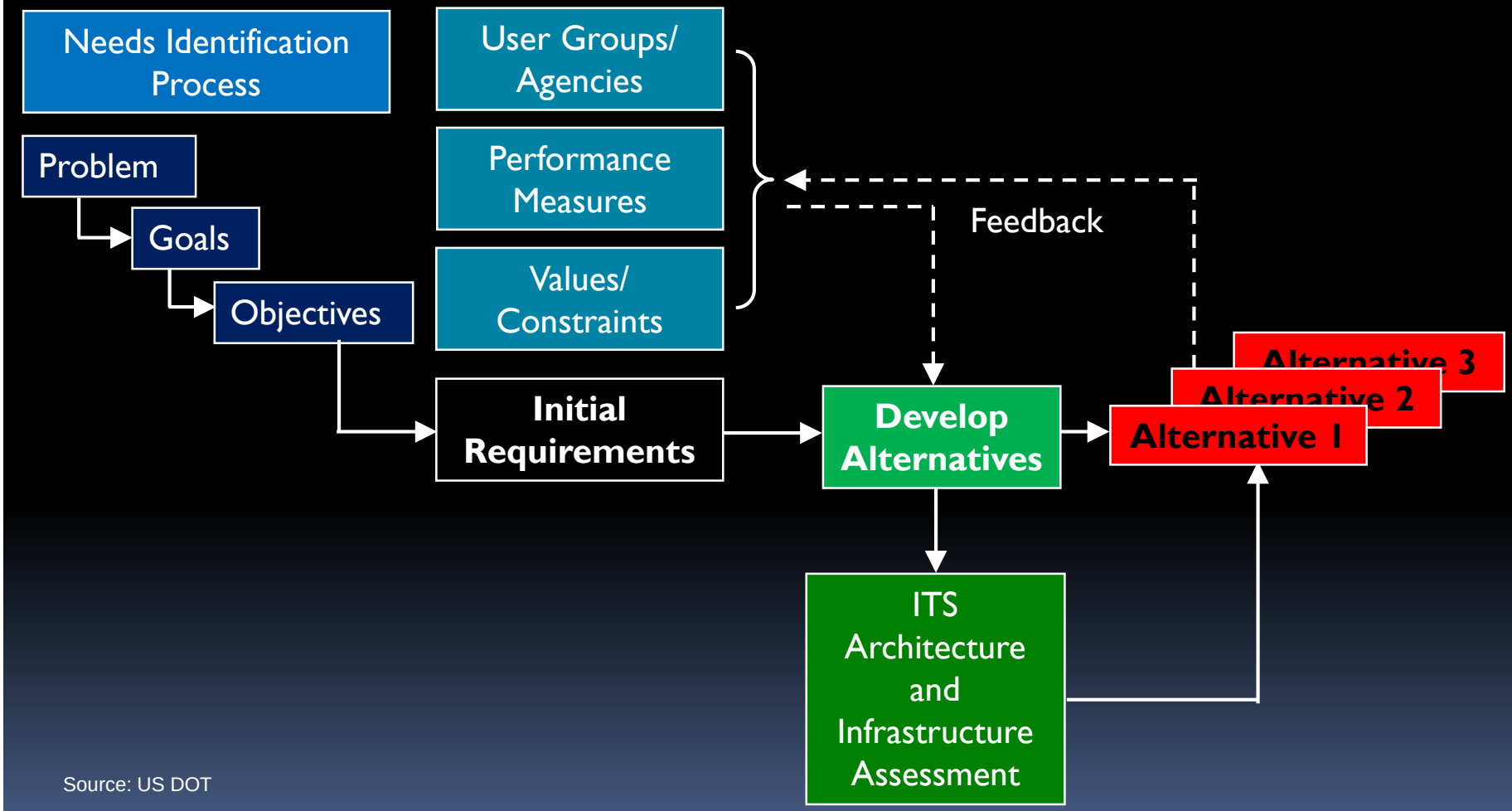
# Developing Alternatives

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# Two Levels of System Design

- High-level design – process of defining hardware, software, and connections to other systems
- Detailed design – defining **how** components are developed to meet requirements
  - Performed by vendor/systems integrator
- Consider previous design experience with similar systems – what worked vs. what didn't work

# Procurement

Key elements of procurement and resulting vendor contract are:

- Providing system requirements
- Ensuring vendors can meet those requirements
- Defining process that vendor must use:
  - System that meets the users' needs
  - Project is on-time and within budget

# RFP Considerations

- Defined set of evaluation criteria:
  - Capabilities of proposed system relative to specification requirements
  - Proposer's experience and installation base
  - Qualifications of specific personnel
  - Price
- Tailored price proposal form
- Requirements compliance matrix

# Effective Vendor/Contractor Relationships

- Regularly schedule conference calls with vendor
- Vendor creates and maintains Action Item List
- Identify feedback and decisions required from agency
- Update technology specifications and implementation program
- Define specific practices and procedures for design review and acceptance testing

# Implementation

- Maintain **system requirements matrix** that records status of each requirement throughout project - for **traceability**
- Conduct **bi-weekly** conference calls or meetings with the vendor
- Define and execute **iterative testing** to ensure that system components:
  - Work as they were intended
  - Work together as a system
  - Meet all requirements

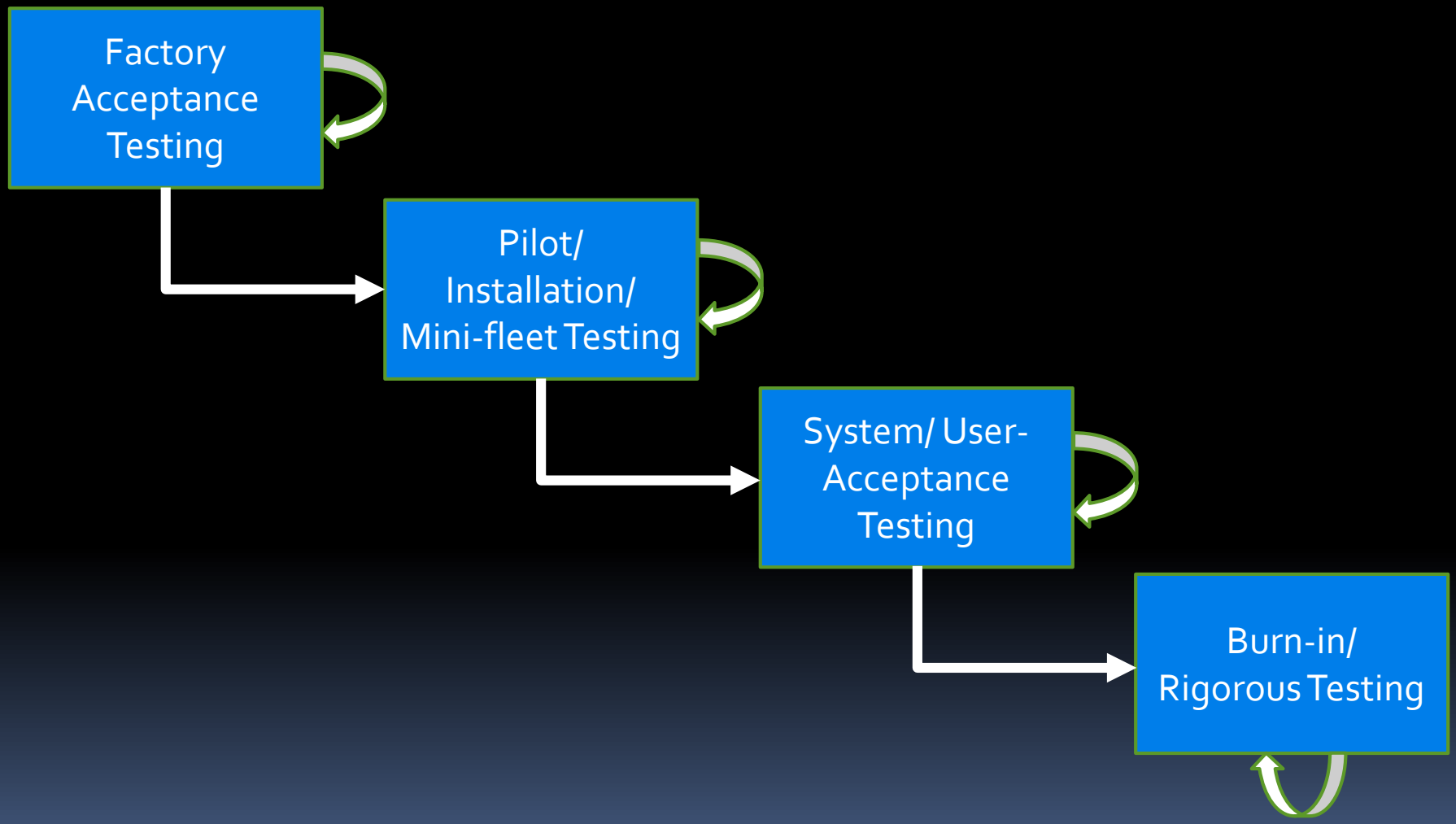
# The Practice of Testing

- Series of **incremental** processes and procedures developed to **verify and validate** system performance
- Objective judgments if system **meets, exceeds, or fails** to meet stated requirements
- **Verify** what was specified and what was delivered
- **Ensure requirements are met** before full system deployment
- Confirm all components **work properly** before system integration and deployment

# Test Procedures Document

- Submitted by vendor before testing takes place
  - Agency must take active role in developing and reviewing
- Test procedures address:
  - How each testable specification requirement will be demonstrated, including method for performing test
  - Results that constitute success for each test
  - Responsibilities of both vendor and agency representatives
  - Cross-reference Requirements Matrix to each test procedure

# Testing Stages

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# Factory Acceptance Test (FAT)

- Typically, final phase of vendor testing **prior to shipment** to the installation site
  - Fully exercises functionality of sub-systems in order to prove design and interface characteristics
  - Intended to simulate installed environment as closely as practical

# Pilot/Installation/Mini-fleet Testing

- At agency facility
- Equipment installation on one vehicle of each type and central system installation
- Field test with installed mini-fleet
- Test all resolved issues from FAT


Source: US DOT

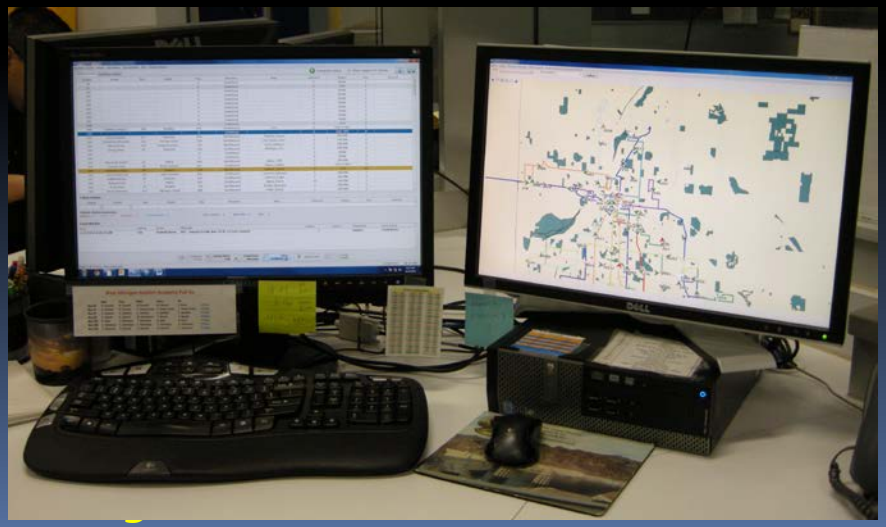
# System/User Acceptance Testing

- Usually with fewest requirements remaining to be verified
  - Subsystem interactions, quantity of field devices, external interfaces, and system performance
- Conducted to identify and correct any system deficiencies

Source: US DOT

# Burn-In and Final System Acceptance

- Normally 30 – 60 day period that new device/software is operated and monitored for proper operation
- If failures during this period, repairs or replacements are made and testing resumes



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# Integration – Connecting Systems

- Successfully combining hardware and software components, sub-systems, and systems into a complete and functioning whole
- System in accordance with the high-level design, requirements, and verification plans and procedures
- All interfaces correctly implemented
- All requirements and constraints are satisfied
- Integration is an iterative process!

# Benefits of Structured Design Approach

- **Reduce time** required to move from concept to deployed systems
- Ensure that system **meets users' needs**
- **Reduce costs** of deploying systems
- Ensure latest **proven technologies** are used
- **Reduce number of changes** required

# Benefits of Structured Design Approach (concluded)

- **Improve system quality**, reliability and performance
- **Improve communications** during design and development
- **Improve ability to sustain** and upgrade systems
- **Reduce development risks**

# Thank You!

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