Cost Modeling for IT System Development and Deployment

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ICEAA 2025

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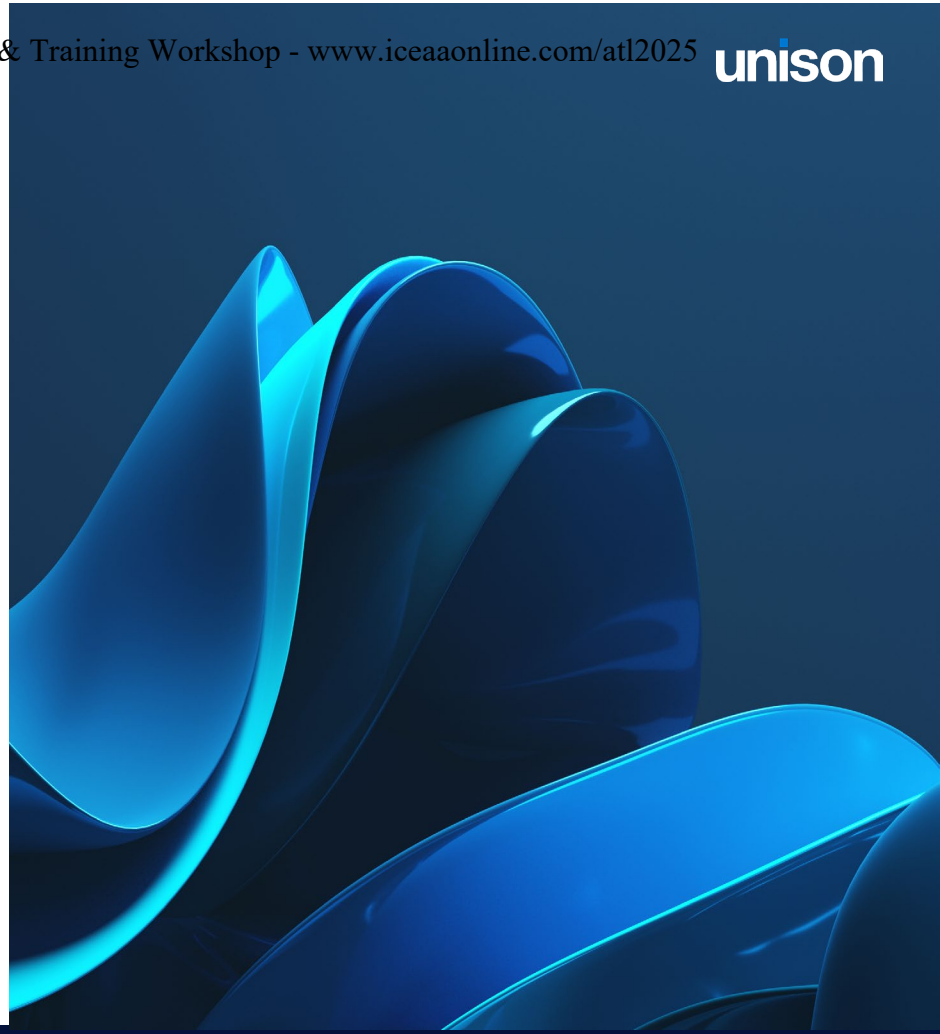
Introduction

- Goal is to enhance our ability to estimate cost/effort for IT system development and deployment projects.
  - Starting point: Bill of materials available.
  - Includes developing configurations for all IT equipment to be deployed, software development, system validation testing, deployment planning, and physical deployment of the system through achieving full operational capability.
  - Focus on ease-of-use, clarity of scope, adaptability.
- Agenda:
  - IT Project WBS
  - Review new model designs:

    Device Configuration and Network Engineering models (Servers, Network Devices, and Field Devices)

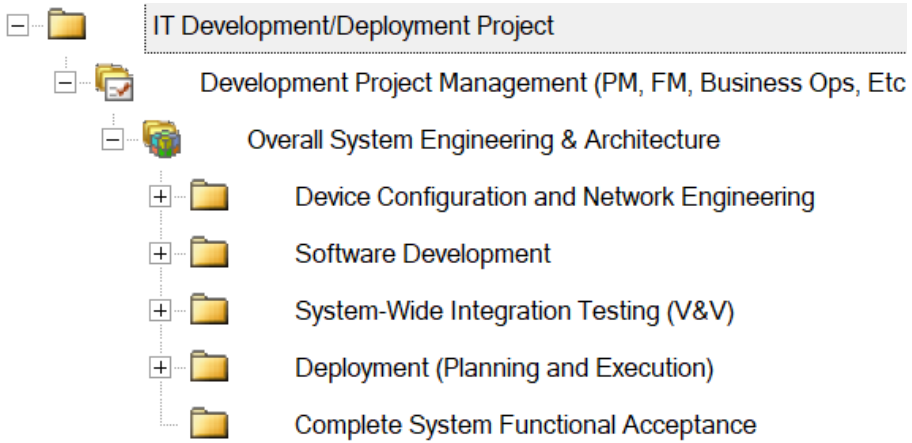
    IT Architecture model

    Legacy System Involvement, Cloud Services
  - Demonstration
  - Future Work



Work Breakdown Structure for IT Development/Deployment Projects

- Device Configuration and Network Engineering
  - Describes the configuration of equipment to be deployed across multiple locations as well as the underlying supporting infrastructure.
- Software Development
  - Describes the design and creation of software to be installed and operate on the servers
- System-wide Integration Testing
  - Describes the verification and validation of the fully integrated system, typically in a “lab” environment.
- Deployment
  - This branch describes the deployment of hardware and software, including deployment planning, site surveys, and physical installation
- Complete System Functional Acceptance



Device Configuration and Network Engineering

- Servers and Network Devices

  Contains IT Infrastructure equipment (servers and various network devices) to be deployed in a datacenter.

  Involves setting up active directory to manage permissions and access to network resources, VM and performance management processes.

  Historically estimated using software estimating models, with size based on function point counts.

- Field Devices

  Contains front-line equipment to be deployed outside the datacenter.

  Involves developing configuration scripts for each device (sensor thresholds, timing settings, power management, etc.) as well as network configuration (connecting to LAN/WAN, data transmission intervals, etc.)

Device Configuration and Network Engineering

- Three new models which estimate the effort for developing configurations of all IT equipment to be deployed
  - Servers
  - Network Devices
  - Field Devices
- White-collar work performed by engineers who create and document scripts for the deployment team that automate the configuration process during site installation.
  - IT Systems Engineer, Network Engineer, Information Security Analyst, DBA, IT Manager
- Main Sizing Metric
  - Number of System Architectures
    - Unique architectures containing this device for which you must develop configuration settings
    - Number of Alternative Configurations (minor modifications to a system architecture) also contributes to size
    - Learning curve

Device Configuration – Key Cost Drivers

Servers

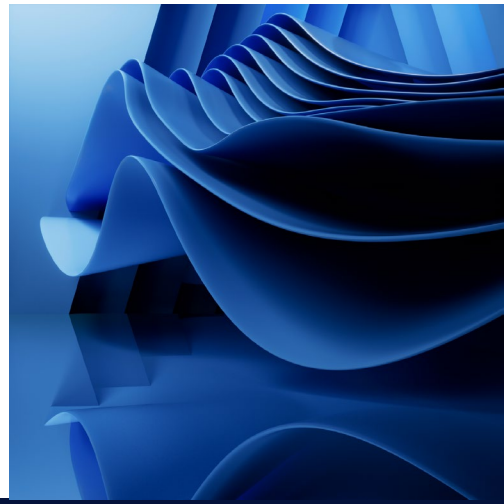
- Software and Operating System Complexity
- Networking and Connectivity Complexity
- Security Requirements and Processes Complexity
- Scalability and Performance Optimization Complexity
- Data Complexity

Network Devices and Field Devices

- Device Type Complexity
  - Network Device types (Routers, Switches, Firewalls, etc.)
  - Field Device types (Cameras, Traffic Signal Controllers, Sensors (Vibration, Air/Water Quality, various weather sensors), Radar Equipment, etc.)
  - Guidance provided to select an appropriate complexity within a range or each type of device, depending on features/purpose.
- Networking and Connectivity Complexity
- Security Complexity
- Data Complexity

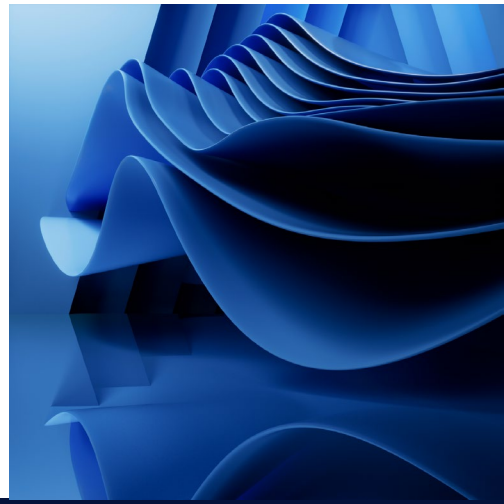
Legacy System Involvement

- Device Configuration Models can represent new or legacy equipment
  - Input “Percent of New Configurations” <100% indicates existing legacy system
  - Legacy Integration Complexity
    - The equipment may be very difficult to integrate (more effort than a new system), or one which can be reused and integrated easily (less effort than a new system).
    - Indicates how outdated the legacy protocols, data formats, and interfaces are and how well established the reuse is (i.e. prior successful integrations with modern systems).
  - Legacy Equipment Experience Level
    - Indicates the team’s familiarity and proficiency with this legacy equipment

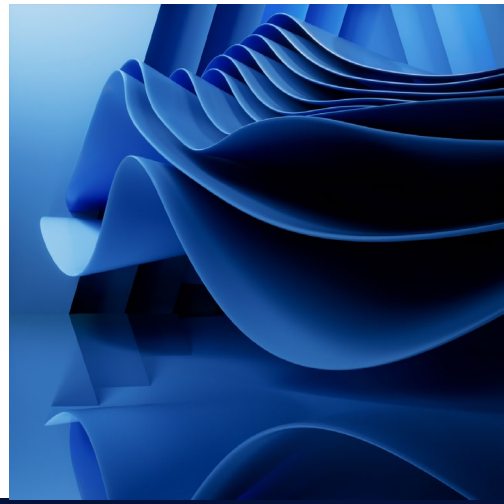


IT Architecture

- Parent model (informed by Device Configuration child models) to estimate:
  - Requirements Definition and Analysis
  - System Design
  - System Test Planning
  - Certification Preparation
- Effort estimated as function of data supplied by child device configuration models (estimated configuration efforts, complexities, etc).
- Other key cost drivers:
  - Regulatory and Certification Requirements
  - Test Environment Setup Complexity

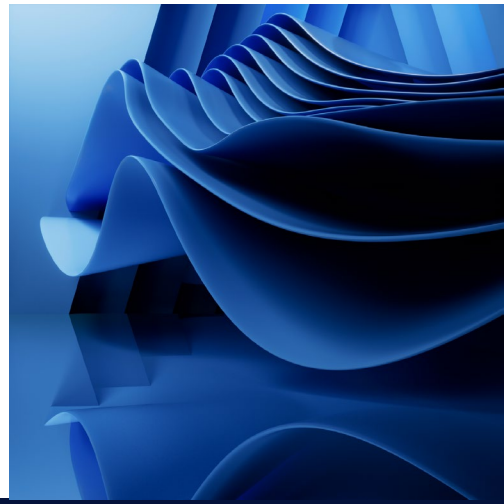


Demonstration



Cloud Services

- Cloud services can be treated similarly to physical IT devices in your system diagram and BOM
- Similarities with physical equipment:
  - Cloud services also require configuration development and network engineering
  - Many shared cost drivers: Cloud Service complexity (often analogous to physical equipment), Security/Data complexity, new vs. reused, legacy integration, team expertise, test environment, etc
- Differences with physical equipment
  - More amenable to large-scale automation
  - Infrastructure-as-a-Service (IaaS) - Resource provisioning is simplified or handled by the cloud provider.
  - Platform-as-a-Service (PaaS) - Often lower effort (many infrastructure details are managed for you), though you still configure parameters and integrations
  - Software-as-a-Service (SaaS) - Often minimal configuration (user setup, access control, basic customizations), but can still require significant effort for data migration and custom integrations.



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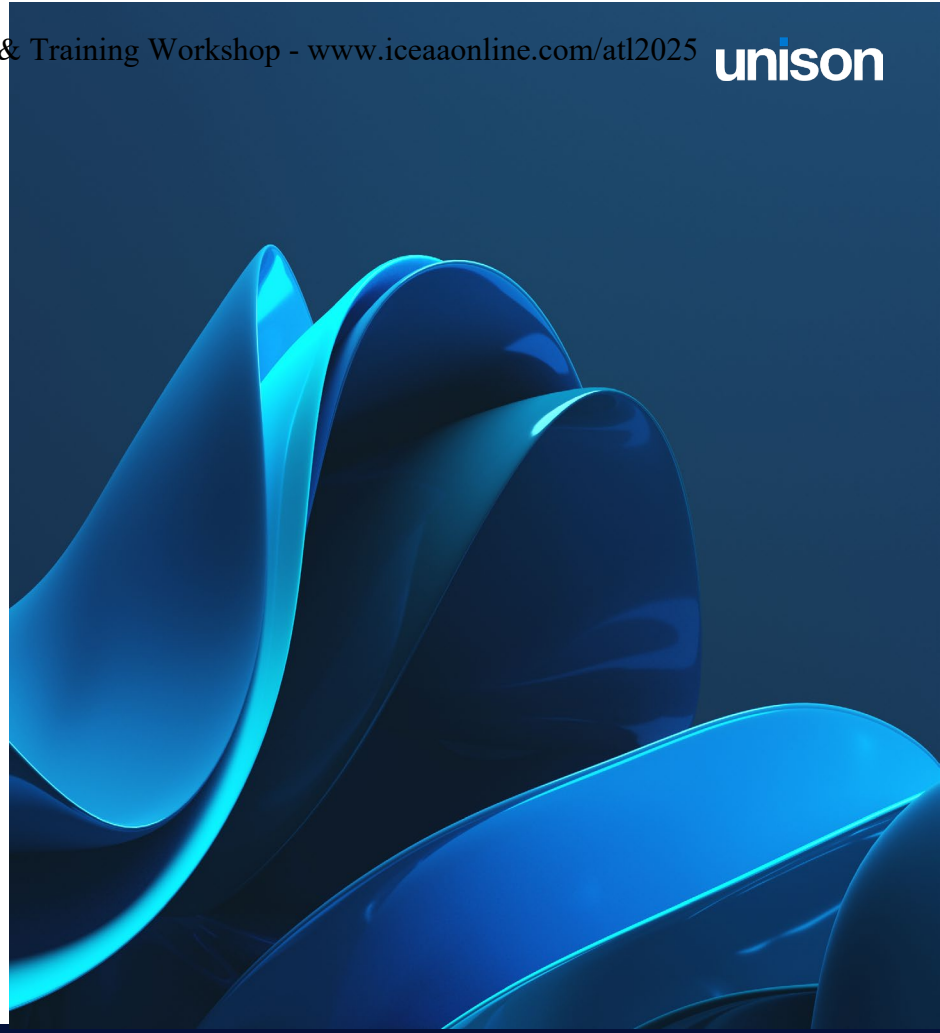
Ongoing/Future Work

- Refine model designs, and calibrate model equations/algorithms with larger datasets
- Cloud Services modeling
- System Validation model
- Redesign Deployment models for improved ease-of-use
  - Make use of information in typical BOMs to quickly inform estimate in user-friendly way.



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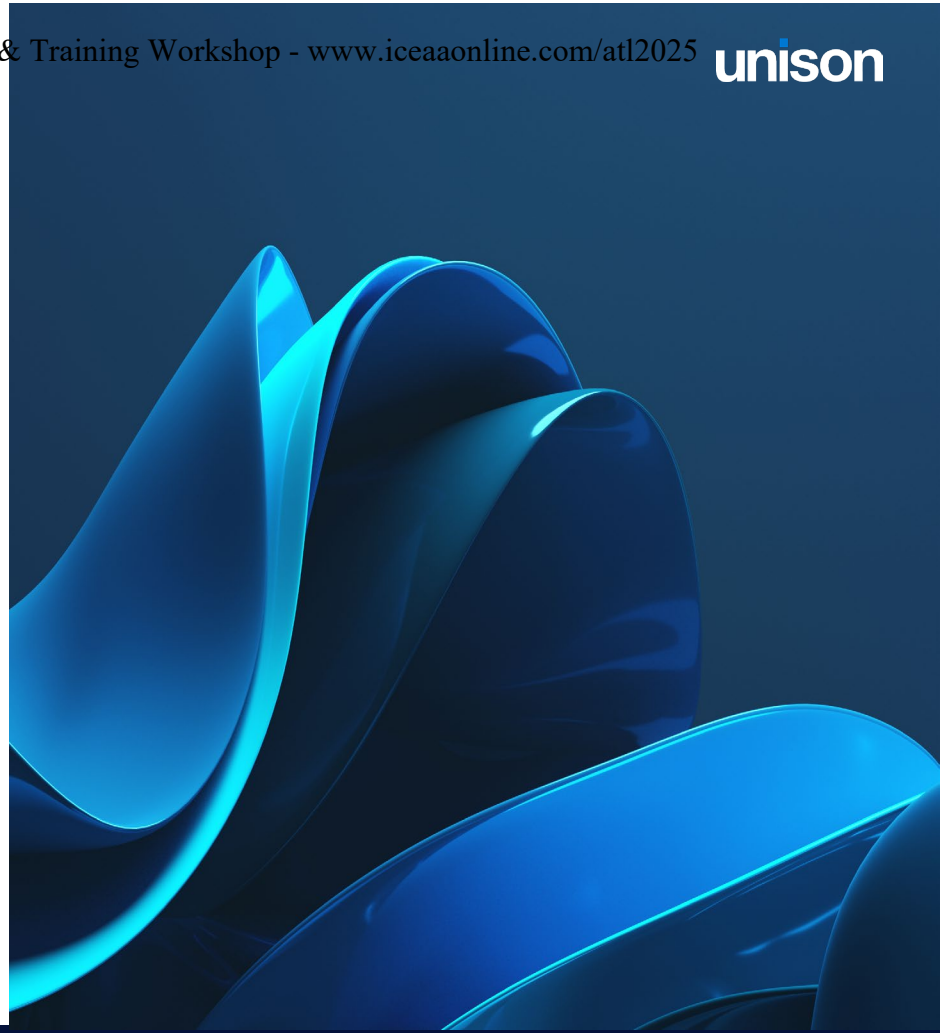
Questions?

Backup Slides

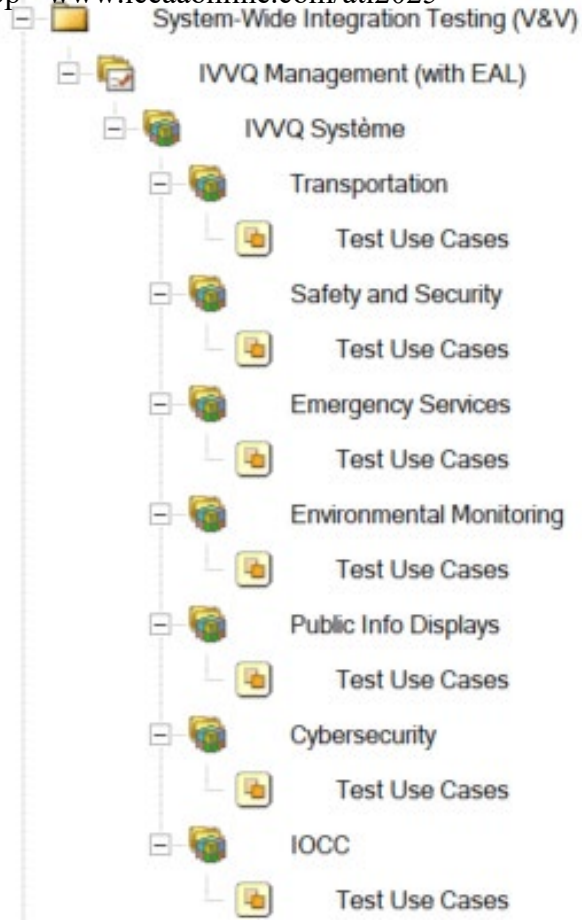


Software Development Branch

- Describes the design and creation of software to be installed on the servers
- This software is used to implement the business logic of the system, manage the connections between the control room and any field devices as well as to process, store and display incoming data. It also functions to protect the system from cyber-attacks and other external threats.
- Includes Applications and Cybersecurity branches.

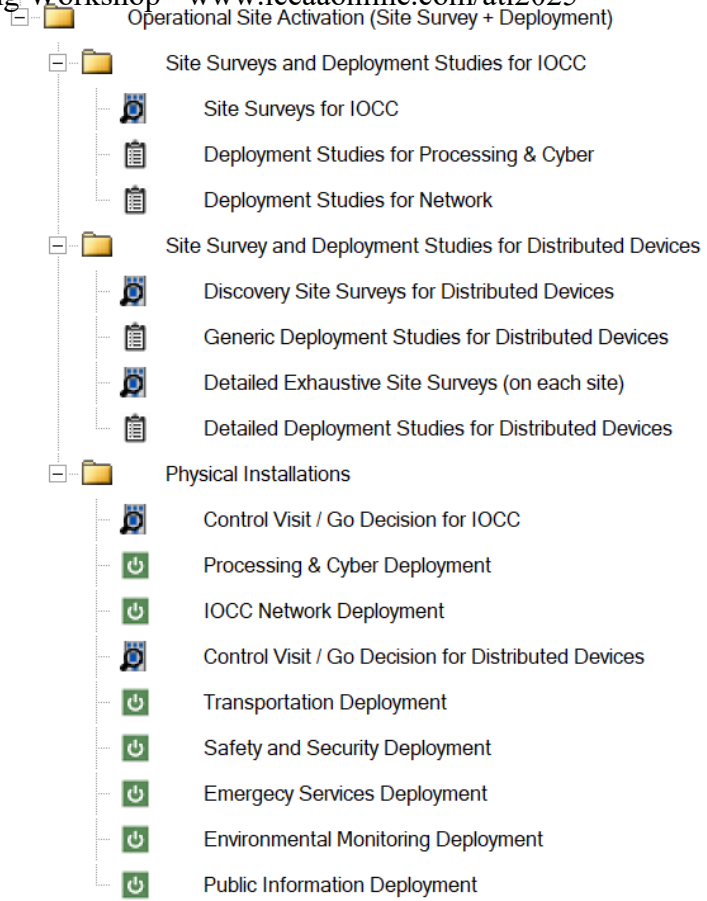
System-Wide Integration Testing

- This branch of the WBS describes the verification and validation of the hardware and software outlined in branches 1 and 2.
- Test cases are run to detect and prevent issues from arising during deployment that may cause delays.
- Efforts sized using Use Case Conversion Points (UCCPs)



Operational and Site Activation

- Describes the deployment and installation of hardware and software from branches 1 and 2
- Takes into account all of the complexities you'll encounter deploying the system in the real world
- Includes
  - Site Surveys
  - Deployment Studies
  - Physical Installations



Operational and Site Activation – Site Surveys and Deployment Studies

- Site Surveys - Visits to prepare for deployment of a system on-site. Occurs before deployment studies.
  - Identify any issues that may arise at the time of deployment.
  - Identify any site-specific adaptations that may affect the configuration
- Deployment Studies - Estimates non-recurring design work and preparation for deployment.
  - Technical studies (System diagrams, study interfaces to existing systems, migration plan, etc.) Includes development of any site-specific system adaptations.
  - Working Groups (Coordinate deployment team, various end users, customer, etc.)
  - Installer Tools and Training
  - Qualification of the process, resources, deployment skills
  - Management

Operational and Site Activation – Physical Installation

- Deployment work performed onsite
  - Identify/Document initial state of site configuration
  - Installation and Configuration of equipment for the new system, and their connections to pre-defined interfaces (network, radio, energy, etc.). Includes testing in “stand-alone” mode.
  - Implementation of operational software and system configurations, full system testing.
  - Acceptance of system in fully operational environment with client/users.
  - Migration of previous configuration data.

Smart City Use Case

- The term ‘Smart City’ describes a technologically modern urban area that collects and leverages data to better manage its resources and services.
- May include the monitoring and management of traffic and transportation systems, utilities, water supply networks, emergency services, information systems, community services, etc.
- Generates, processes, and distributes enormous quantities of data.
- Enabled by an information and communication technology infrastructure that satisfies the following:
  - Automated and Simplified Network Management
  - Automatic security threat isolation and remediation
  - Internet of Things (IoT) enabled
  - Robust and scalable
- Same estimating approaches applicable to many kinds of electronic system development and deployment projects

Traffic Signal Controllers

- Common intro to PLC programming homework assignment is to program a very simple (vehicle only, 4 directions, fixed timings) which takes about 30min-1hour.
- Complicating Factors: Additional vehicle directions/routes, single-vs-multi-lane, pedestrian signals (possibly with non-visual cues), reliability (redundancy, system health monitoring equipment), data collection equipment for optimization of signal timings, synchronization with other nearby traffic signals, red light cameras

Field Devices

- 1. Cameras (Image sensors):
- 2. Traffic Signal Controllers
- 3. Information/Message Systems
- 4. Vibration Sensors
- 5. Water Quality Sensors
- 6. Smoke sensors
- 7. Unnatural Sound sensors
- 8. Motion Sensors
- 9. Pressure Sensors
- 10. Wind Speed Sensors
- 11. Temperature Sensors
- 12. Rainfall Sensors
- 13. Humidity Sensors

Deployment Studies - Size Drivers

- "Size" based on 4 drivers
  - Number of System Architectures

    Number of system architecture diagrams, describing the hardware and/or software components and how they integrate with each other.
  - Number of Alternative Configurations

    Minor adaptations of the system architecture.
  - Max Number of Equipment Types

    Unique equipment types defined in System Architecture diagram
  - Number of External Interfaces

    Power, networking, satellite datalink, sensors, etc.

Deployment Studies – Complexity Drivers

- Operating Specification
  - Ground-Stationary, Ground-Mobile, Ship, Aircraft, etc.
- SW and System Configuration
  - Use provided installation guide? Adapt the installation guide? Create new?
- Cabling/Mechanical
  - Simple cabling/wiring requirements? Complex? Lots of site-specific adaptations required?
- Systems
  - SW/IT, Command and Control, Weapon System, Optronic/Radar, Complex Multi-Equipment
- Communication Technology
  - LAN, WAN, WiFi, Bluetooth, Radio, Complex Mix
- Processing/Analysis/Computation Equipment
  - SW/IT only, PC/HD, Servers
- Software
  - Simple COTS? Complex COTS? Simple New Dev? Complex New Dev?
- Power Distribution
  - Power provided on-site, ready to go? Write start/stop procedures? Site-specific adaptations?
- Foreign Language Complications

Site Survey and Deployment – Cost Drivers

- "Size" based on
  - Number of System Deployments
  - Percentage of Sites Surveyed
  - End User Workspaces per Site
- "Complexity" score based on 13 different areas of complexity
  - Many of the same from Deployment Studies, plus:
  - Number of Deployment Site Locations
  - Country Access Complexity
  - Danger Level
  - Installation Environment

    Indoor/Outdoor, Install in Building/Vehicle/Ship/Aircraft

    Quantity/Weight of Equipment
  - End User Workspace Complexity
  - Migration Complexity