

Ground Systems Cost Estimation: Modeling Ground Systems in the Aerospace Concept Design Center

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Introduction

- Sometimes ground systems are given little attention in the early design phase of space systems,
 - *Ground systems designs should be considered early in the architecting of systems to avoid unanticipated risks and costs*
- Providing a structure for defining ground systems can facilitate the simulation of performance and cost implications early in the design phase of a program
- This presentation will provide insight on the process used to derive ground systems costs in The Aerospace Corporation's Concept Design Center

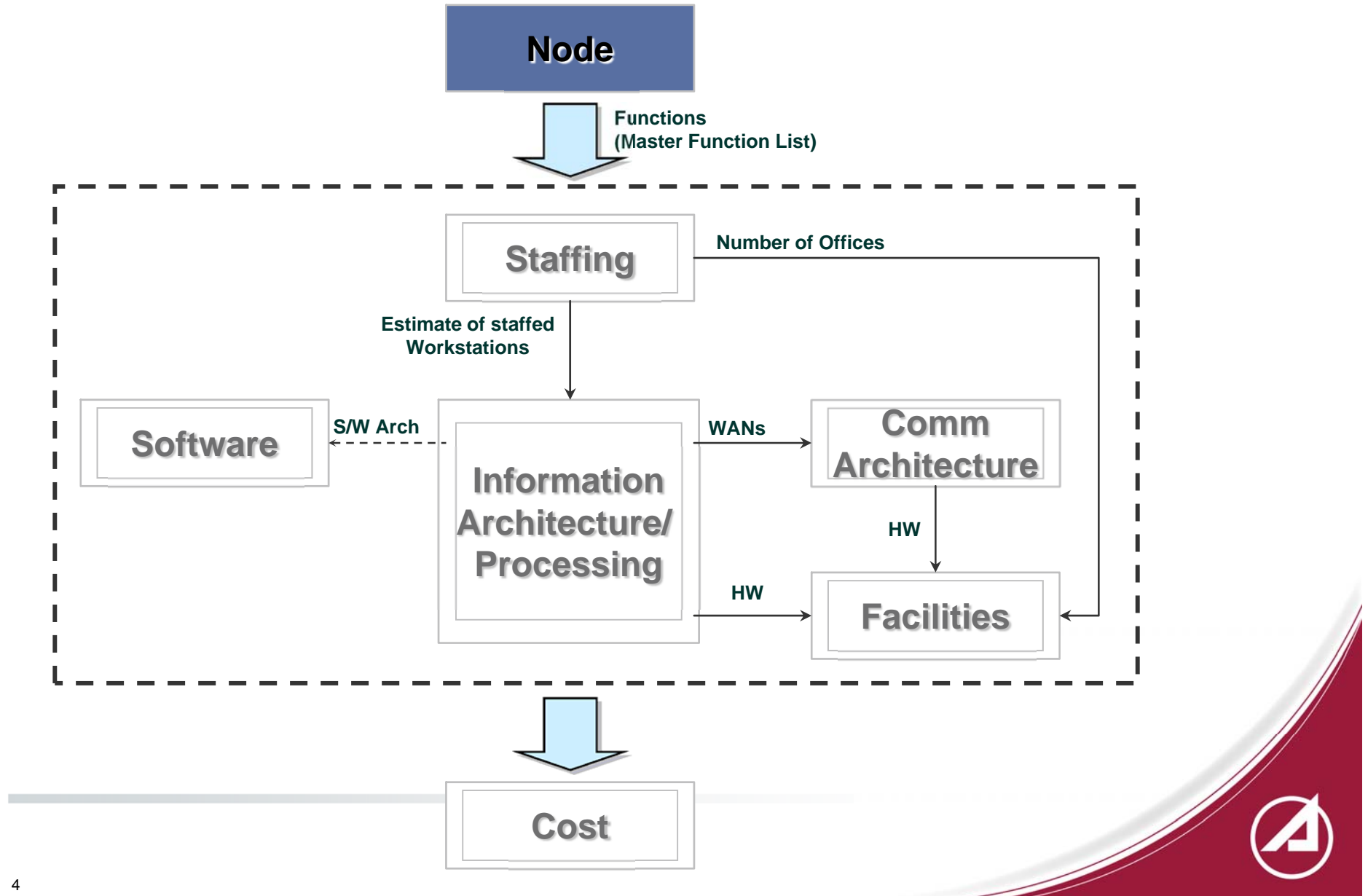


Overview

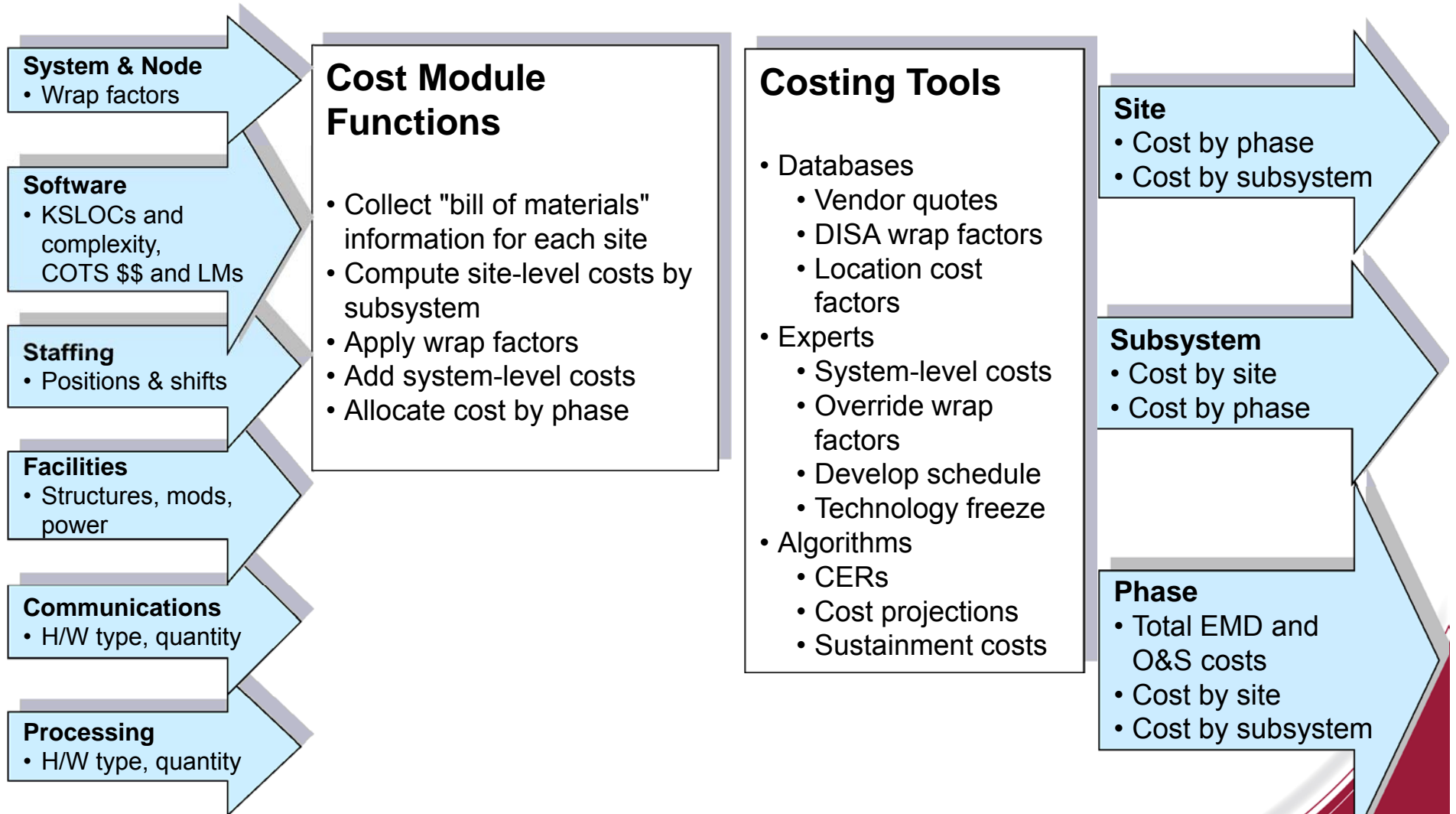
- Ground Systems Estimation Structure
- Major WBS Elements
- Cost Estimation Process: Software Example
- Typical Cost Drivers
- Cost Estimation Challenges



Ground Systems Estimation Structure



Major WBS Elements: Input & Output Metrics



Module Structure Example: Software Estimation Process

Each GST module relies on tools: Databases, Experts and Algorithms as illustrated below:

Software Module Functions

- Specify major software functions
- Specify software function elements
- Specify software implementation parameters
 - New Code
 - Reuse SLOC
 - COTS use
- Specify coding difficulty and IV&V use

Design Tools

Databases

- Provides historical data on software size and characteristics

Experts

- Assess COTS availability
- Specify labor effort for COTS integration and database population
- Specify complexity level

Algorithms

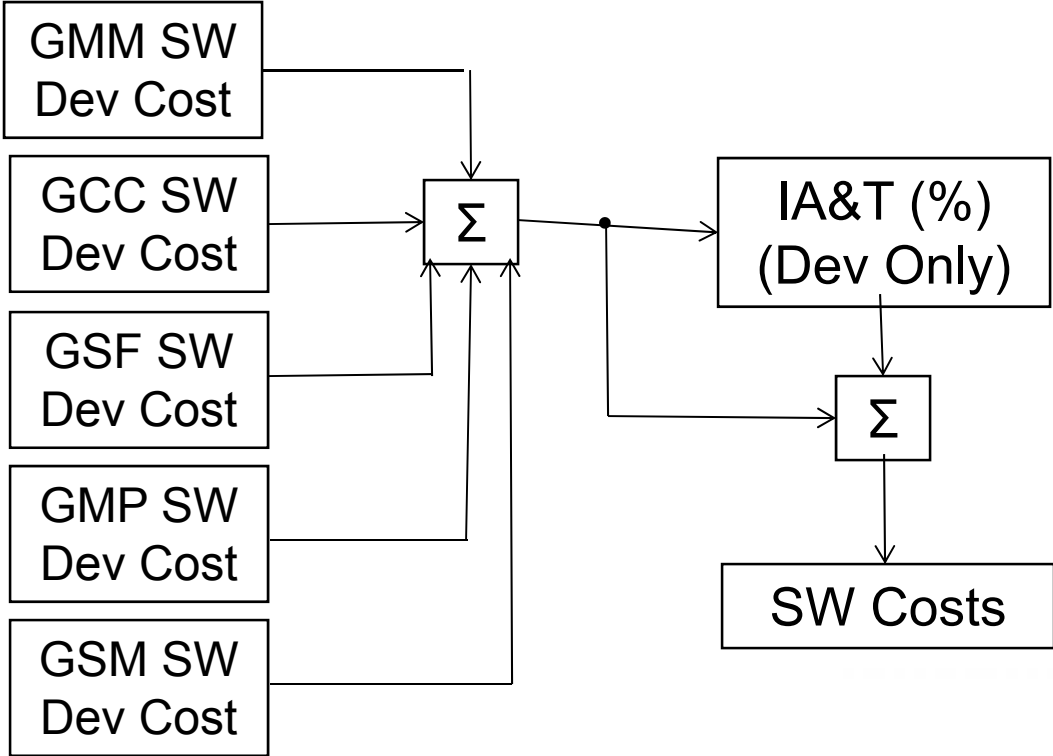
- Access reuse and node-level replication factor

Cost Module

- S/W SLOC
 - Developed
 - Maintained
- S/W development labor
- COTS s/w cost



Cost Estimation Process: Ground Software



Actual percents can vary widely



Node Level WBS

WBS Element	1/27/2014 6:34	Development (Custom)	COTS (Single Node)	Total EMD	O&M (Dev. Items)	O&M (COTS)	Total O&M	Average Annual O&M	Total LCC
NodeTotal (FY14\$M)									
Program Level (Node) (FY14 \$K)									
1.1.1 SE/PM (Node Level) Sustaining Eng (O&M)									
1.1.2 Development Engineering									
1.1.3 Documentation									
1.1.4 Training									
Integration Assembly & Test (FY14 \$K)									
Software (FY14 \$K)									
1.3.1 Ground Mission Management									
1.3.2 Ground Command And Control									
1.3.3 Ground Support Functions									
1.3.4 Ground Mission Processing									
1.3.5 Ground System Management									
1.3.6 SW IA&T									
Processing (HW & Network Eq) (FY14 \$K)									
Communications (FY14 \$K)									
1.5.1 Local Connections									
1.5.2 RF Terminals									
Facilities (FY14 \$K)									
Personnel (FY14 \$K)									
G&A (FY14 \$K)									
Fee (FY14 \$K)									
OGC (FY14 \$K)									



Typical Cost Drivers

- EMD
 - *Software Development (New or reused software? Integrating into and existing operational system?)*
 - *Processing and Communications (New antennas, ground terminals?)*
 - *Facilities (New building or upgrade existing footprint? Security ?)*
 - *Information Assurance (COTS software, configuration & administration, testing, security specific hardware and staff)*
- O&M
 - *Number of years of maintenance*
 - *Number of nodes to maintain and number of software and hardware refresh cycles over the life of the mission*
 - *Number of Personnel required to sustain the system (consider functions performed over mission duration)*
 - *Terrestrial Communications (usage charges?)*



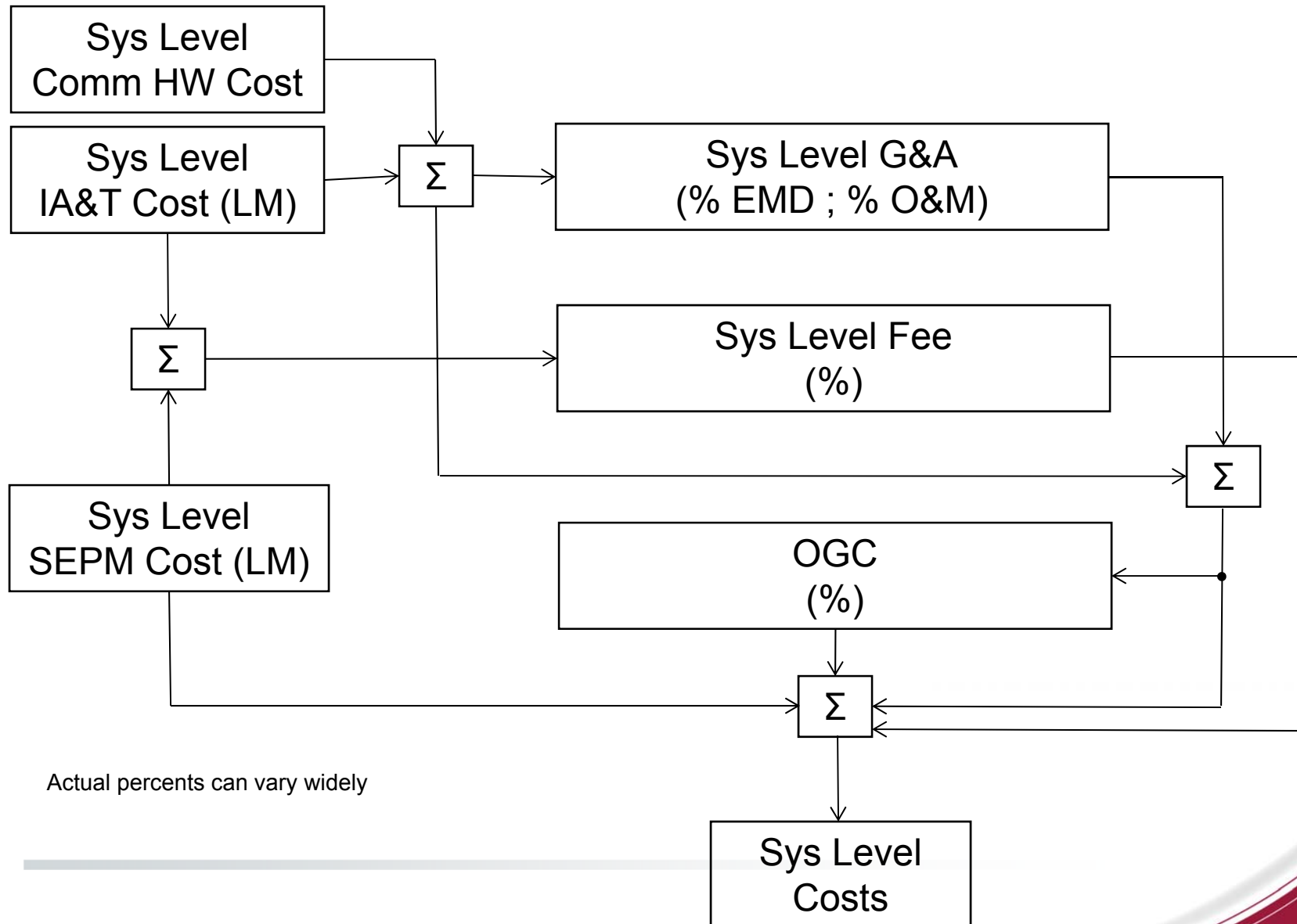
Cost Estimation Challenges

- Data collection must be performed periodically
 - *Model structure consists of lookup tables, factors, and CERs*
 - *Data gathering activities performed every 2-3 years for COTS hardware software products*
 - *Software sizing metrics updated as information becomes available*
- Cost model is not turn-key
 - *Experienced cost analyst required to operate the tool*
 - *Each study has unique mission requirements that necessitate custom tailoring of model inputs*
- Estimates produced are considered ROM estimates
 - *The results are useful for simulating cost impacts due to selected changes in systems designs and can provide much insight into cost implications for various program alternatives*
 - *Significantly more data is required to produce estimates comparable in fidelity to a POE or ICE*



Backup

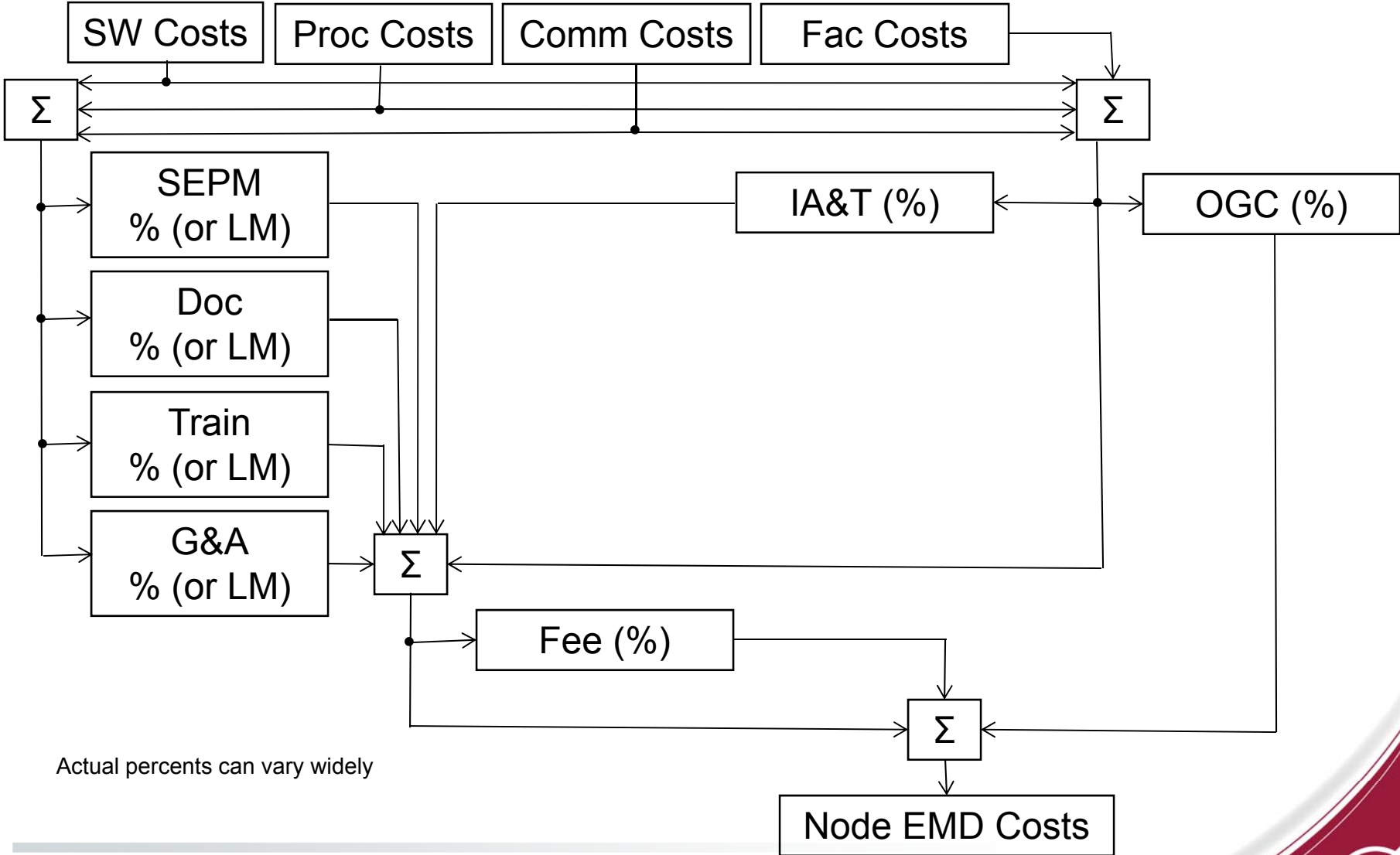
Cost Estimation Process: System Level (EMD/O&M)



Actual percents can vary widely



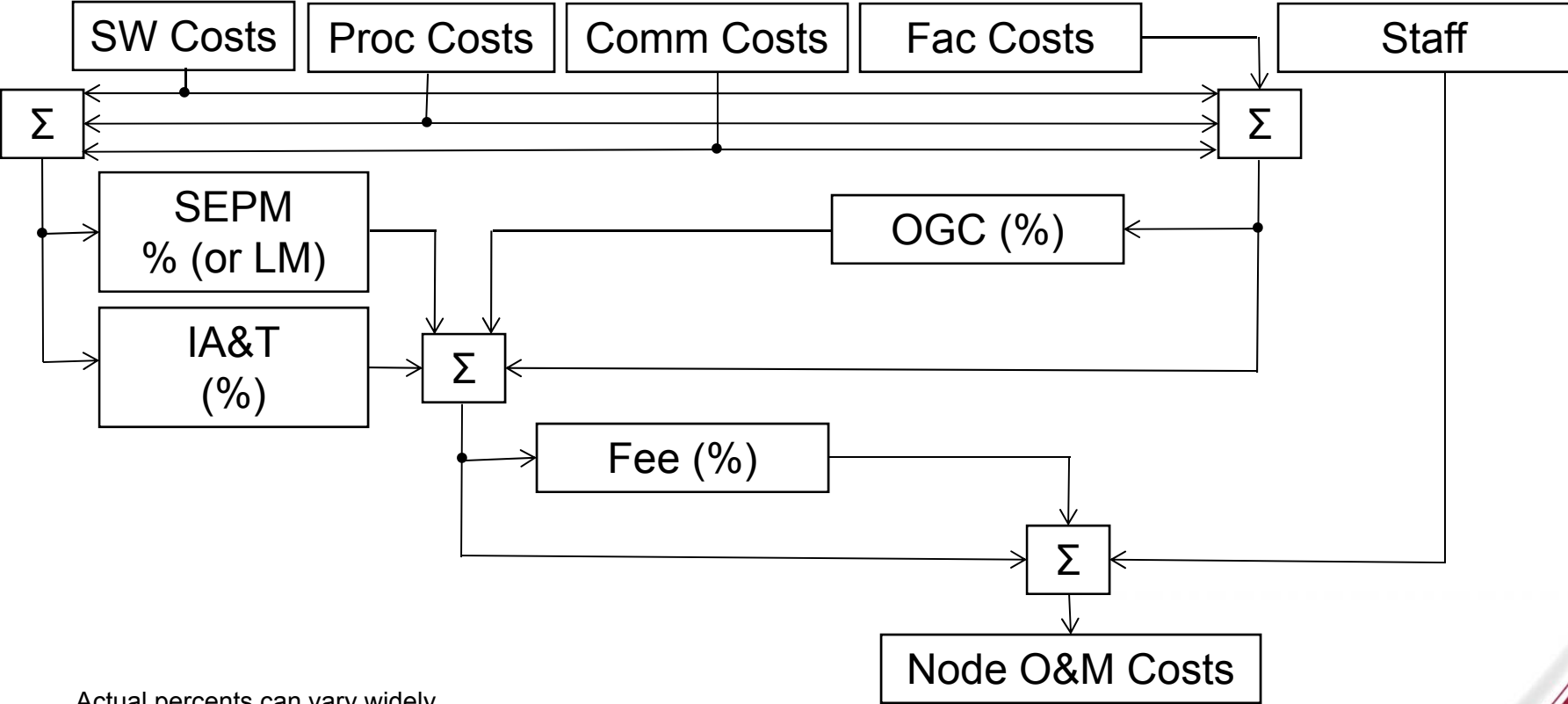
Cost Estimation Process: Ground Node EMD



Actual percents can vary widely



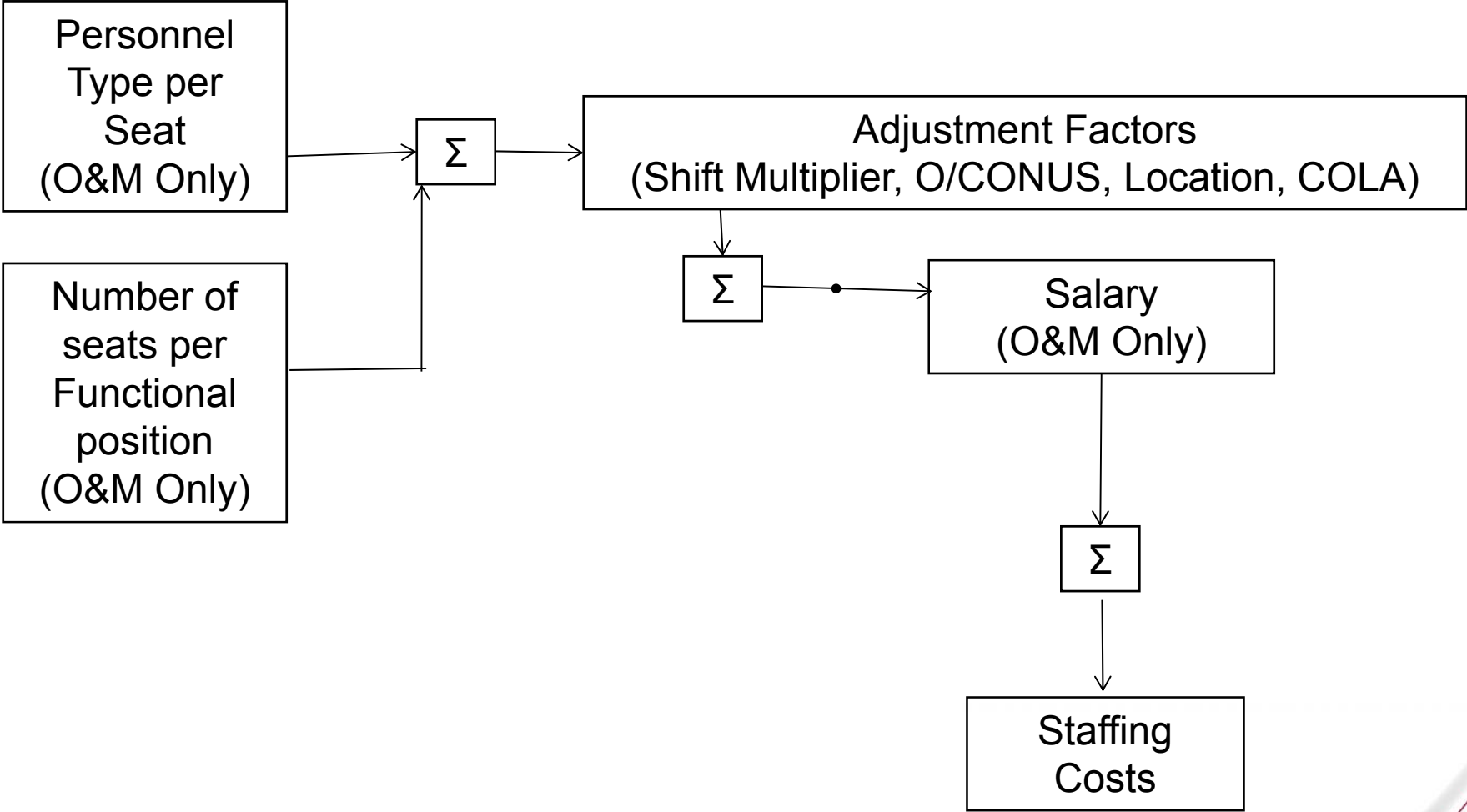
Cost Estimation Process: Ground Node O&M



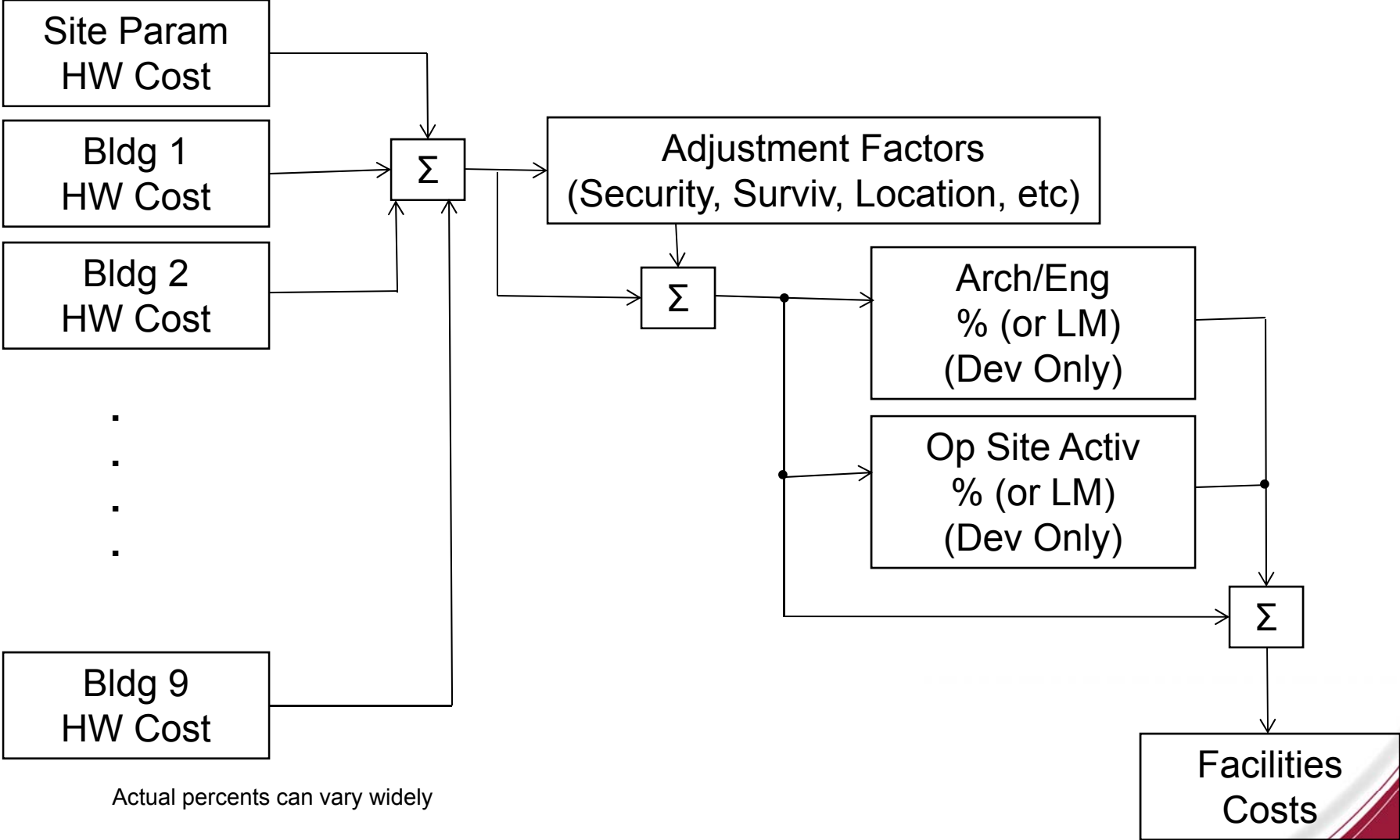
Actual percents can vary widely



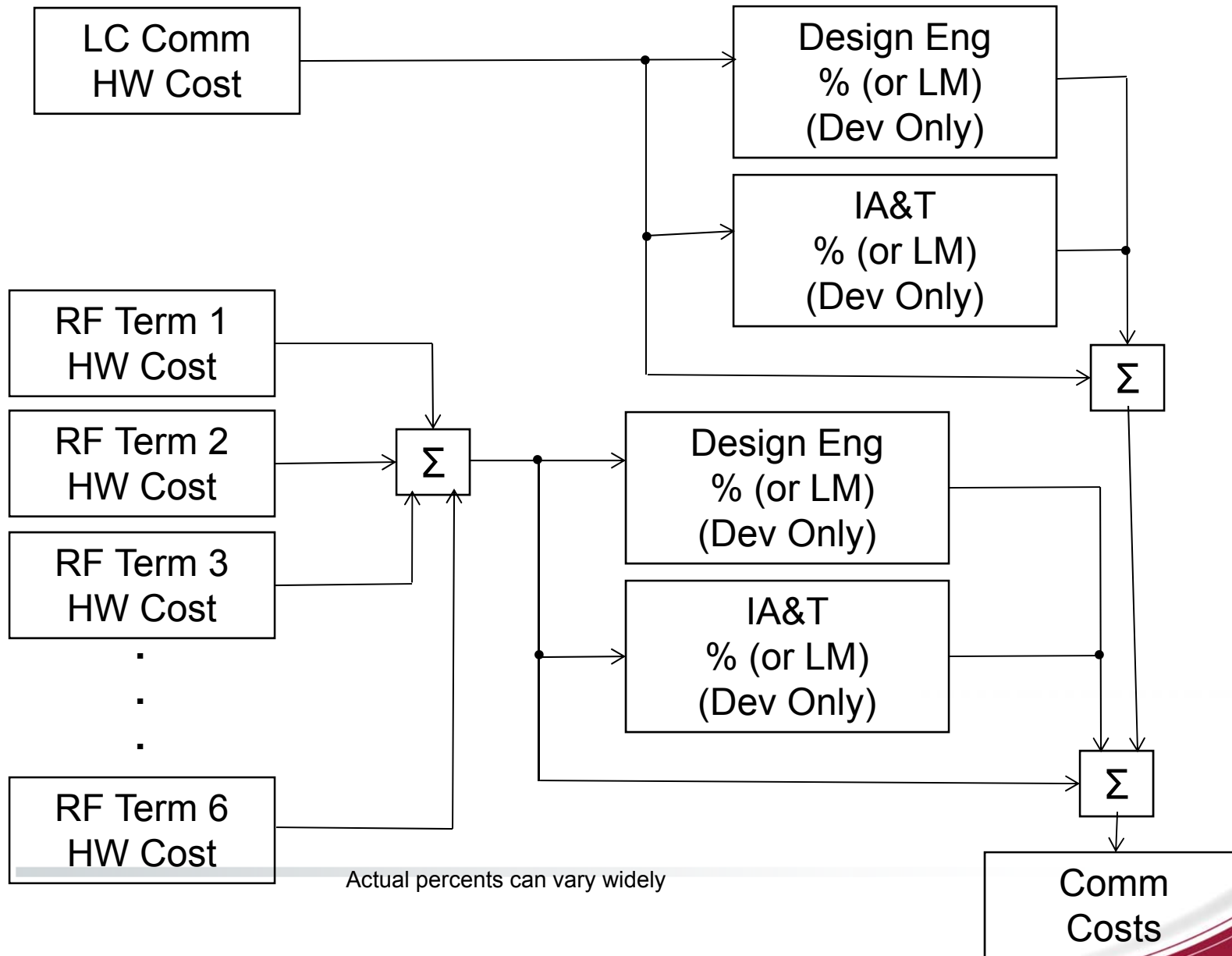
Cost Estimation Process: Staffing



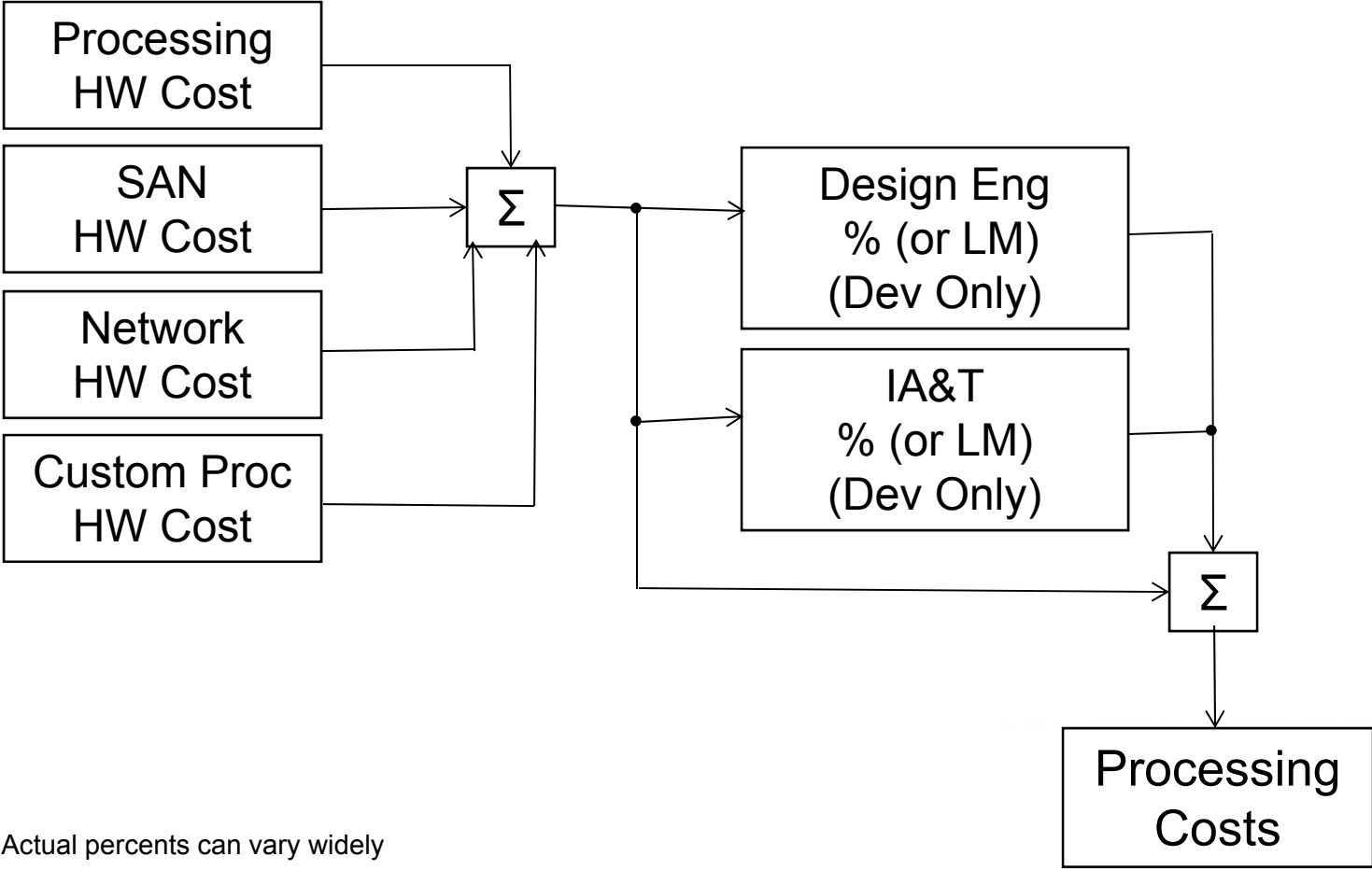
Cost Estimation Process: Facilities



Cost Estimation Process: Ground Communications



Cost Estimation Process: Ground Processing



Actual percents can vary widely

