2004 Command and Control Research and Technology Symposium
The Power of Information Age Concepts and Technologies

An Activity-Based Methodology* (ABM) for Development and Analysis of Integrated DoD Architectures: "*The Art of Architecture*"

C2 Assessment & Tools, #077
June 2004

Steve Ring, MITRE Corporation, sring@mitre.org
Dave Nicholson, MITRE Corporation, dnichols@mitre.org
Jim Thilenius, MITRE Corporation, jethilen@mitre.org
Stanley Harris, Lockheed-Martin, stanley.harris@lmco.com

* Activity-Based Methodology is a concept developed by The MITRE Corporation and Lockheed-Martin, Copyright © 2003

Vendor Participation

Popkin Software

…System Architect v9.1.40 based on ABM publically announced 5/18/2004

Proforma Corporation

…initial discussions held with Chief Methodologist Brian James in March

…webx demo provided in May – 3-way OV-5 in-place

Computas/Metis

…Preliminary discussions held with Chief Consultant Don Hodge 12/2003

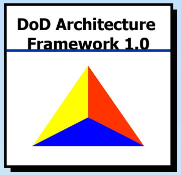
Agenda

- **Define integrated architectures**
- **Present Activity-Based Methodology**
- **Present ABM Architecture Description Specification Model – "ADSM"**
- **Show numerous integrated architecture analysis techniques and strategies**

- **Present steps to integrated Operational and System Architecture Descriptions- the "*Art of Architecting*"**

➢ ***Present "dynamic" architecture descriptions transitioned from integrated "static" architectures***

Start With Integrated Architecture Descriptions



DoD Architecture Framework v1.0

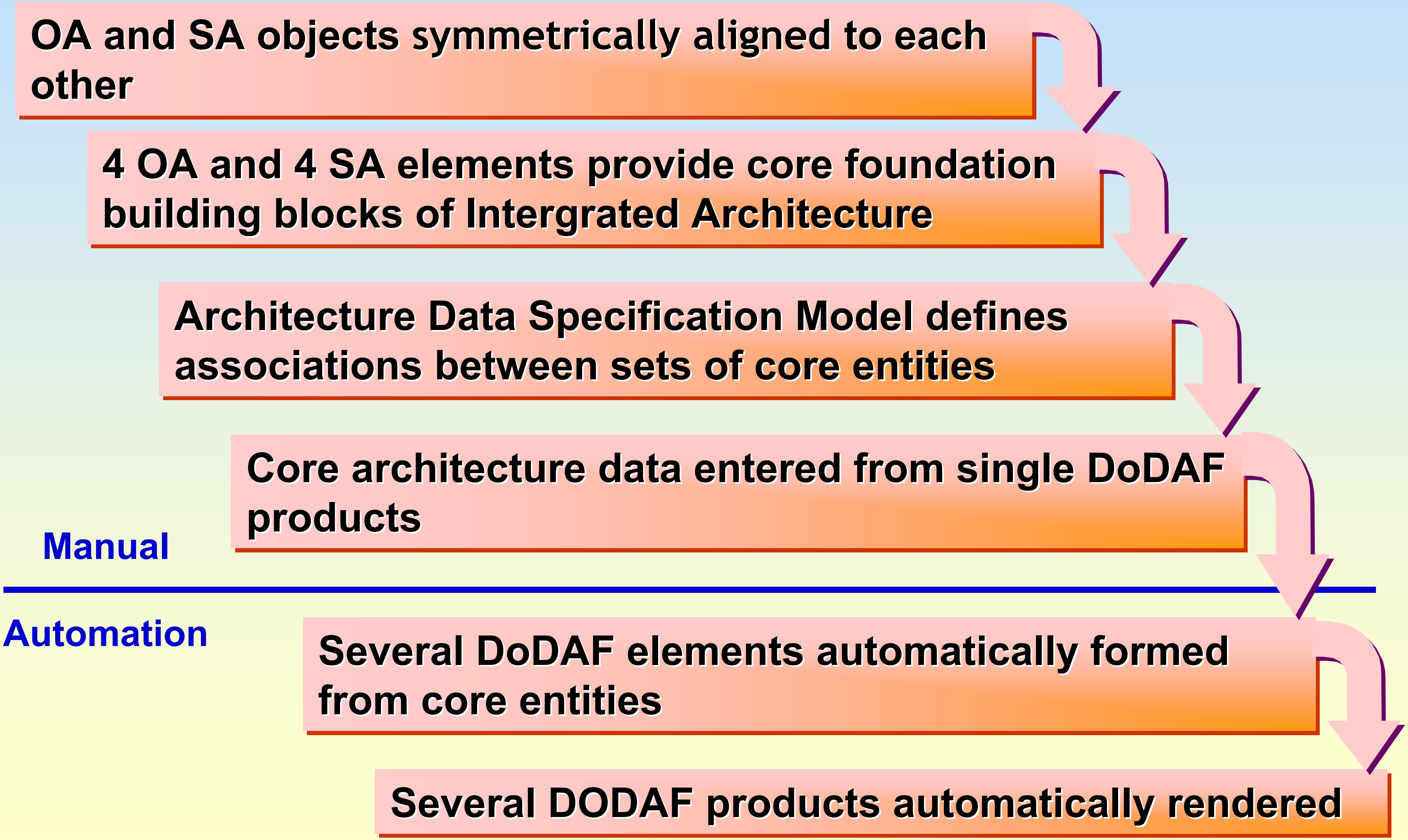
- Before you can use architecture descriptions for any type of analysis purposes ***you must first have an architecture*** that is
  - ***Integrated, unambiguous, and consistent***
- What's an *Integrated Architecture*?
  - Based on DOD Architecture Framework (DoDAF)
    - (1) Integrated Operational and System views (via SV-5) within ***single architecture*** - AV-1, AV-2, OV-2, OV-3, OV-5, SV-1, and TV-1 *+ OV-4 the forgotten product, key to DOTLMPF*
    - (2) Integrated architectures between and among ***multiple architectures***
  - *Joint Capabilities Integration and Development System Process (JCIDS)*
- DoD Architecture Repository System (DARS) provides source of ***authoritative architecture***
  - Populated with DoD architecture information built in accordance with the DoDAF
  - Store legacy, draft, and approved architecture information developed by the Commands, Services and Agencies
  - Enable sharing, exchange and reuse of architecture data

What Is *Activity-Based Methodology*?

- Consists of a tool-independent approach to developing fully *integrated, unambiguous, and consistent* DODAF views
- Enables both
  - "*As-Is*" (now) architectures - all details known
  - "*To-Be*" (future) architectures - based on unknowns and abstract elements where not all details known
    - "To-Be" architectures must support "*gap-analysis*" to discover future unknown rules, patterns, practices, relationships, and requirements

- Uses *data centric* approach for architecture element and product rendering
    - Supports cross-product relationships based on core set of architecture elements
    - Simplified "architecture specification model" of architecture elements and their associations/relationships based on DoDAF and not CADM
- Captures sufficient representations of architectures models to transition to "*dynamic*" executable process models

Methodology Based on Six Principles



OA and SA objects symmetrically aligned to each other

4 OA and 4 SA elements provide core foundation building blocks of Intergrated Architecture

Architecture Data Specification Model defines associations between sets of core entities

Core architecture data entered from single DoDAF products

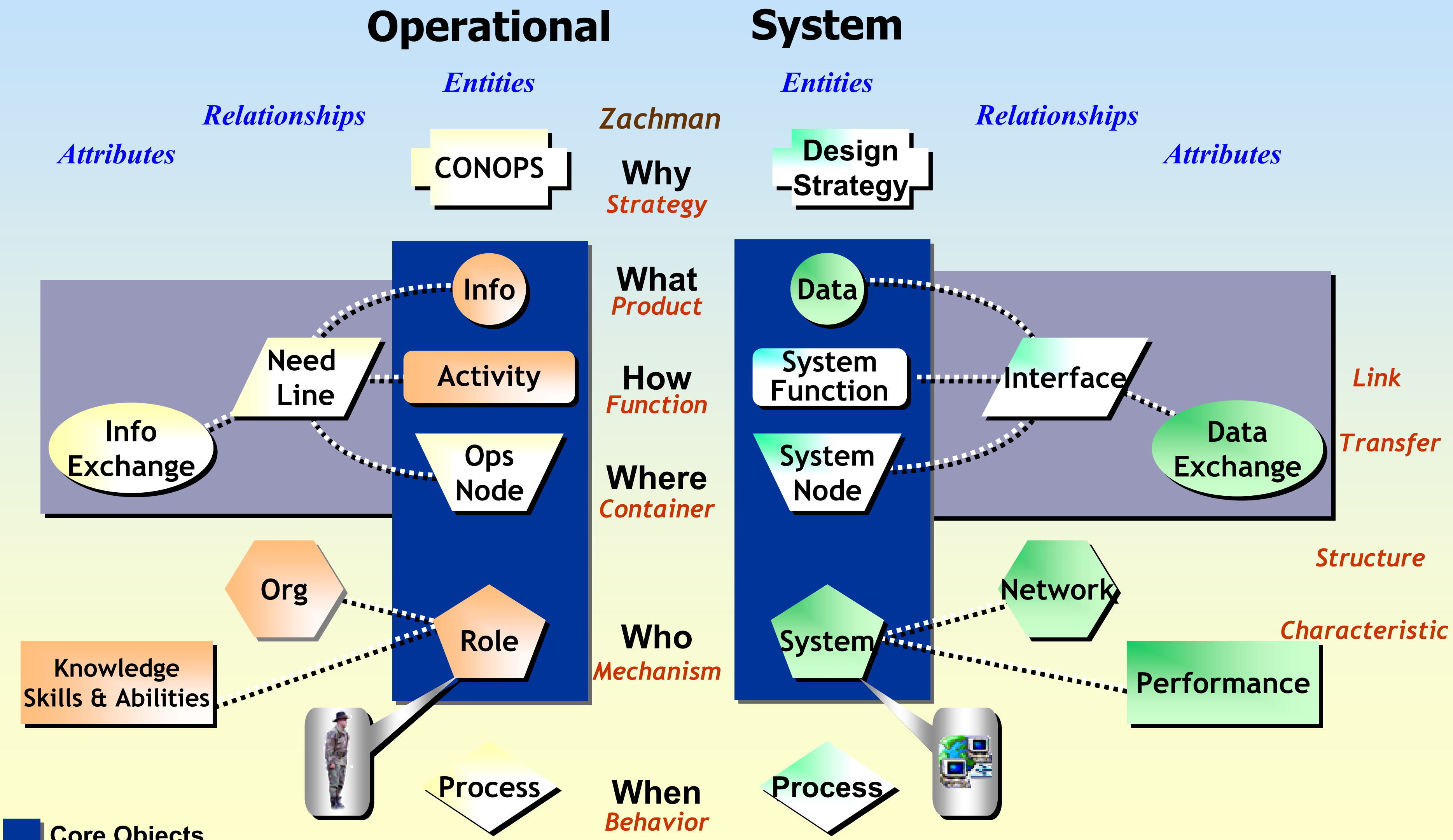
Manual

Automation

Several DoDAF elements automatically formed from core entities

Several DODAF products automatically rendered

Symmetrically Aligned DoDAF Architecture Objects

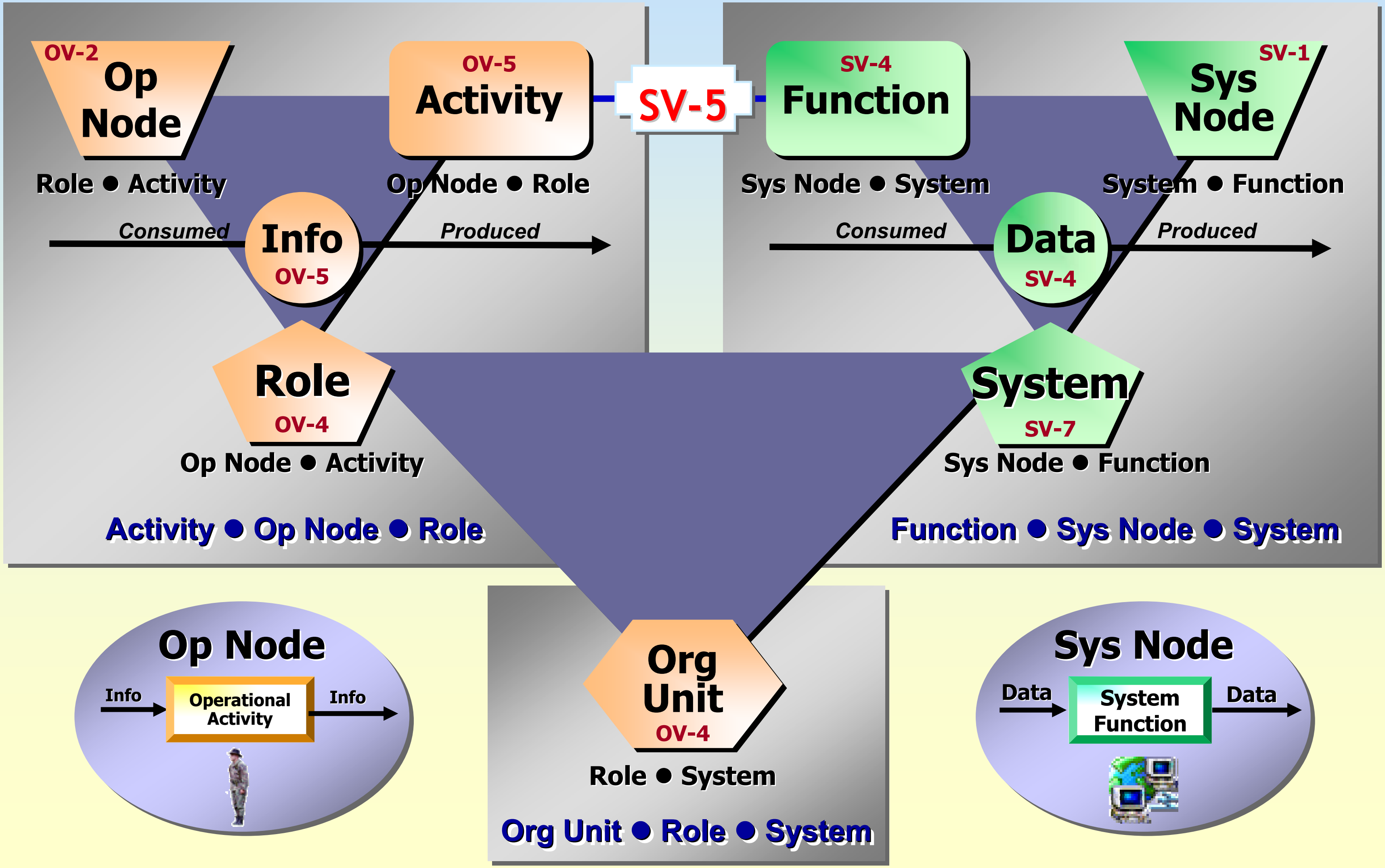


▇ Core Objects

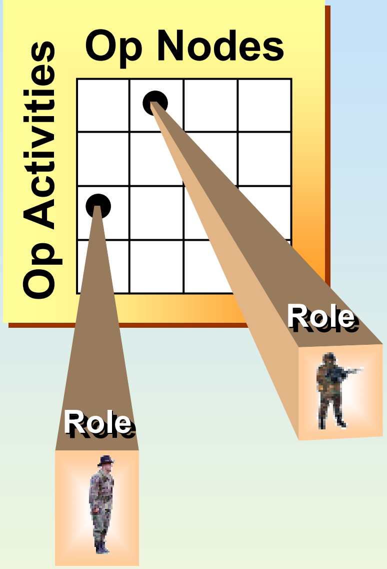
▨ Generated Objects

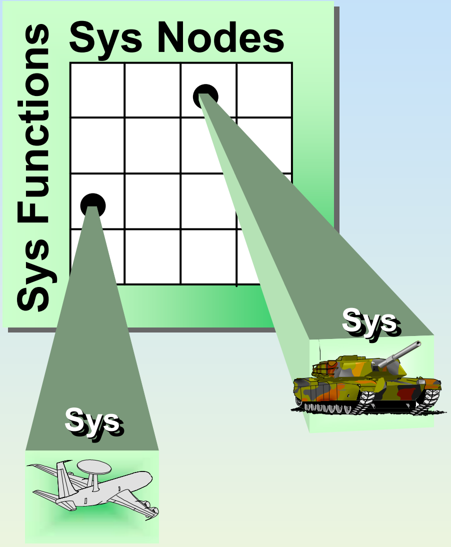
Associations between Core Entities Forms Foundation of an Integrated Architecture

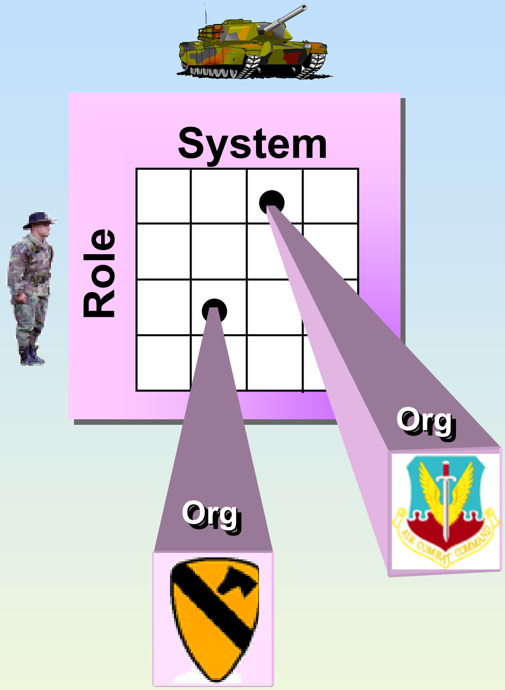
Triple 3-way Associations of Core Entities

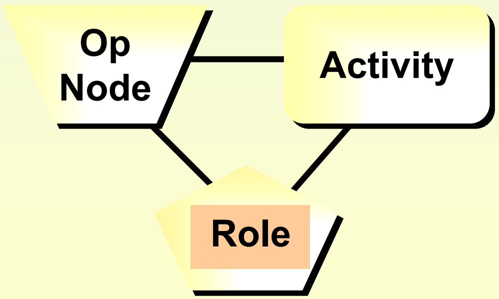


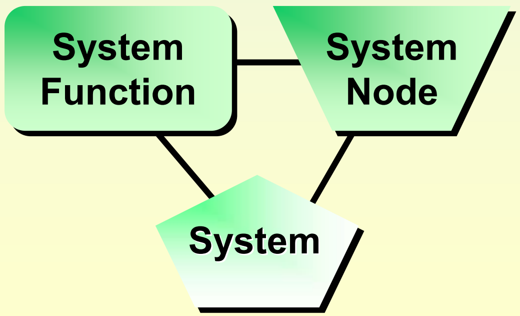
Triple 3-way Associations of Core Entities

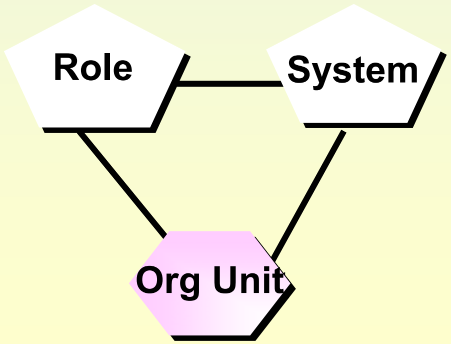




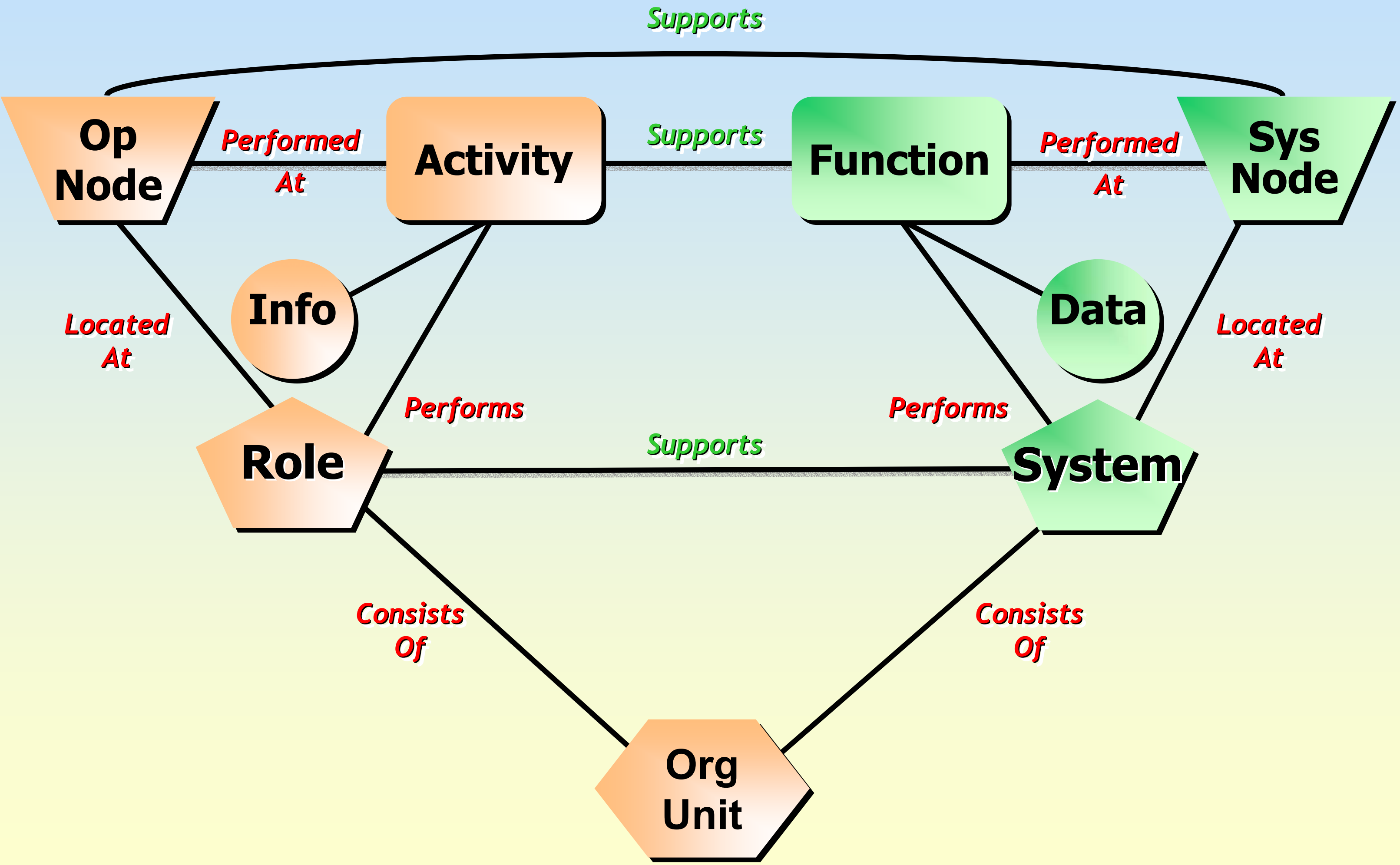






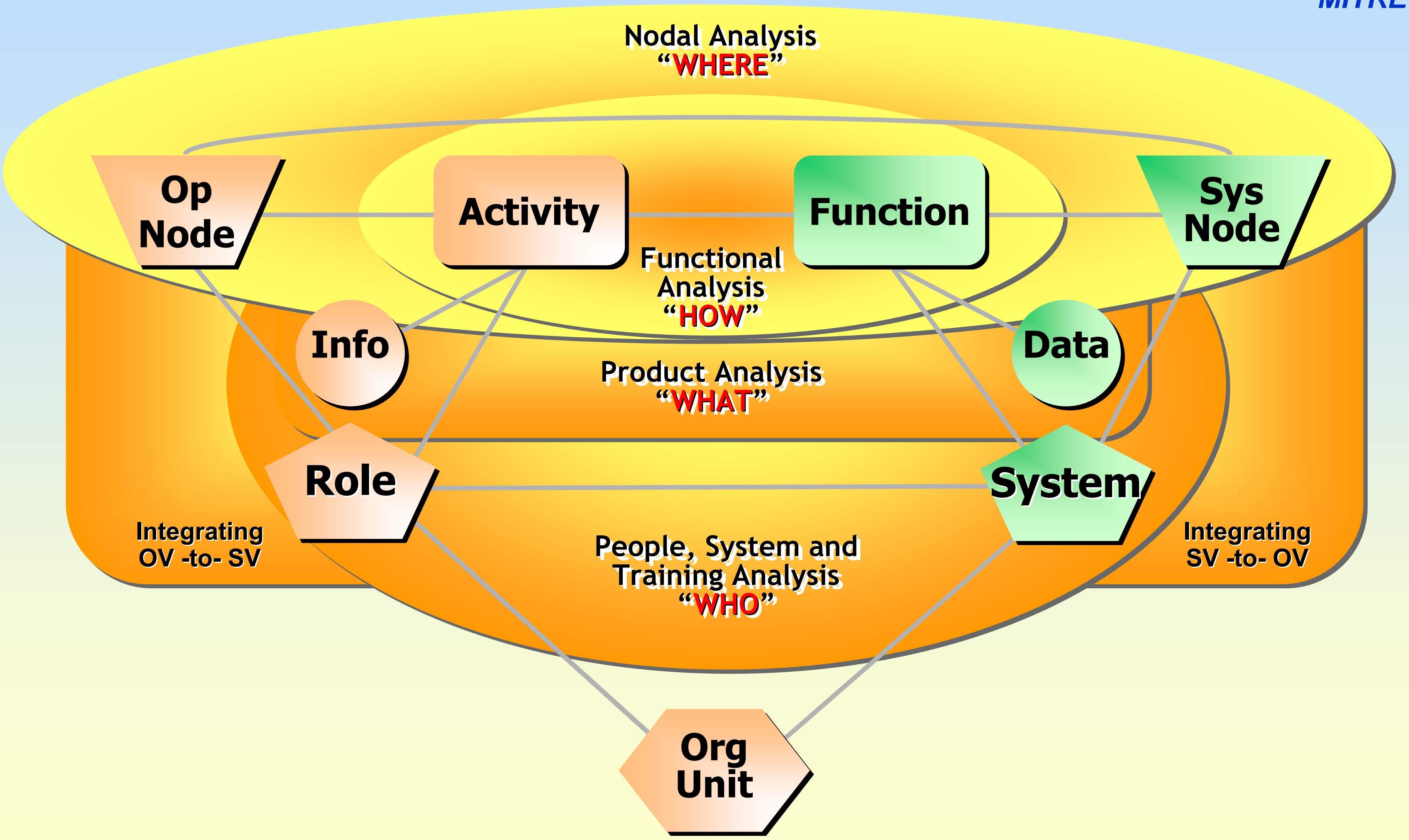


Integrated Architecture Represented as Architecture Data Specification Model – "ADSM"

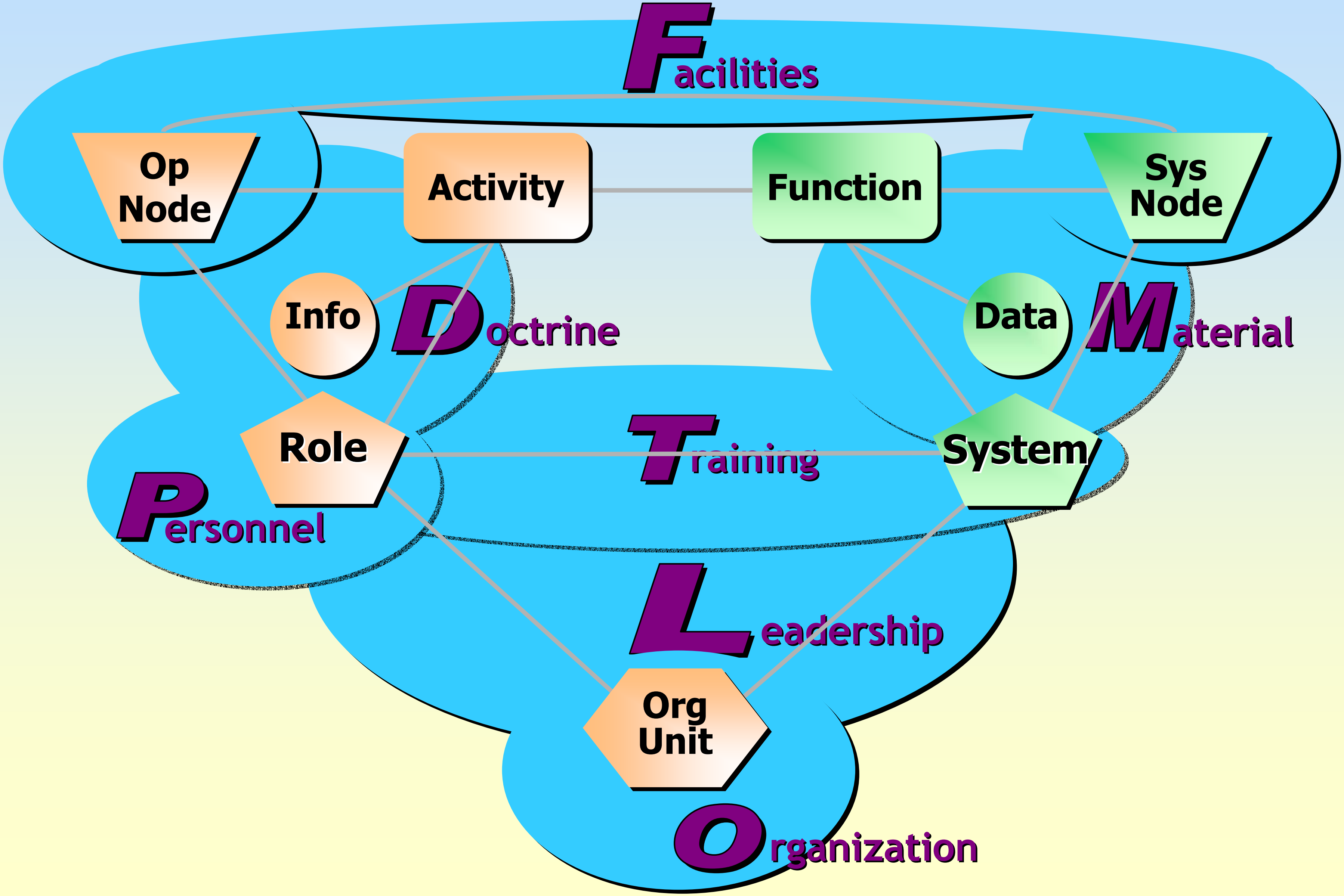


Integrated Architecture Data Analysis

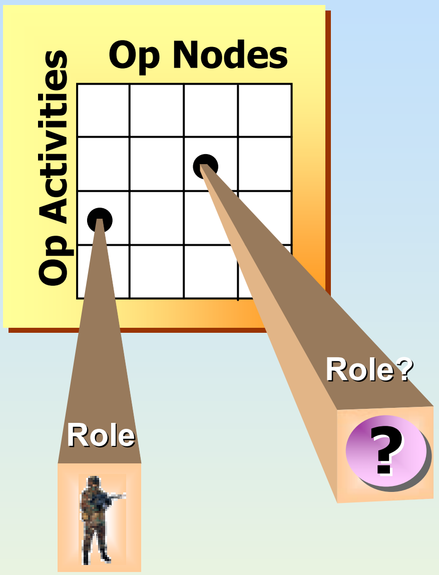
MITRE

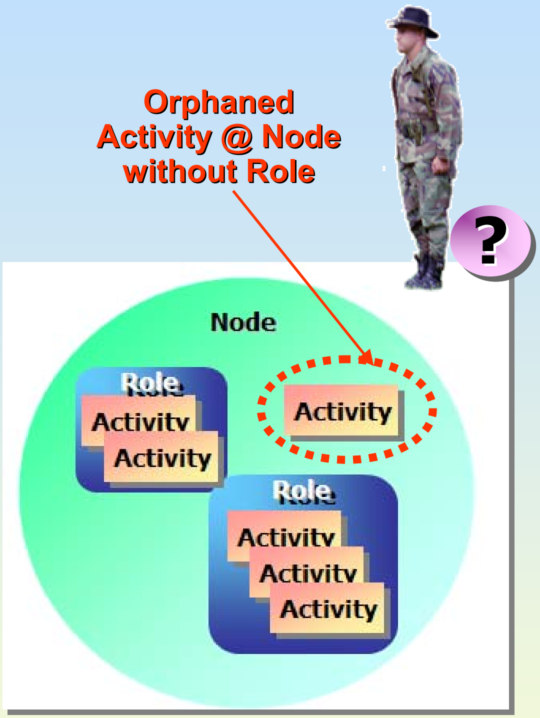


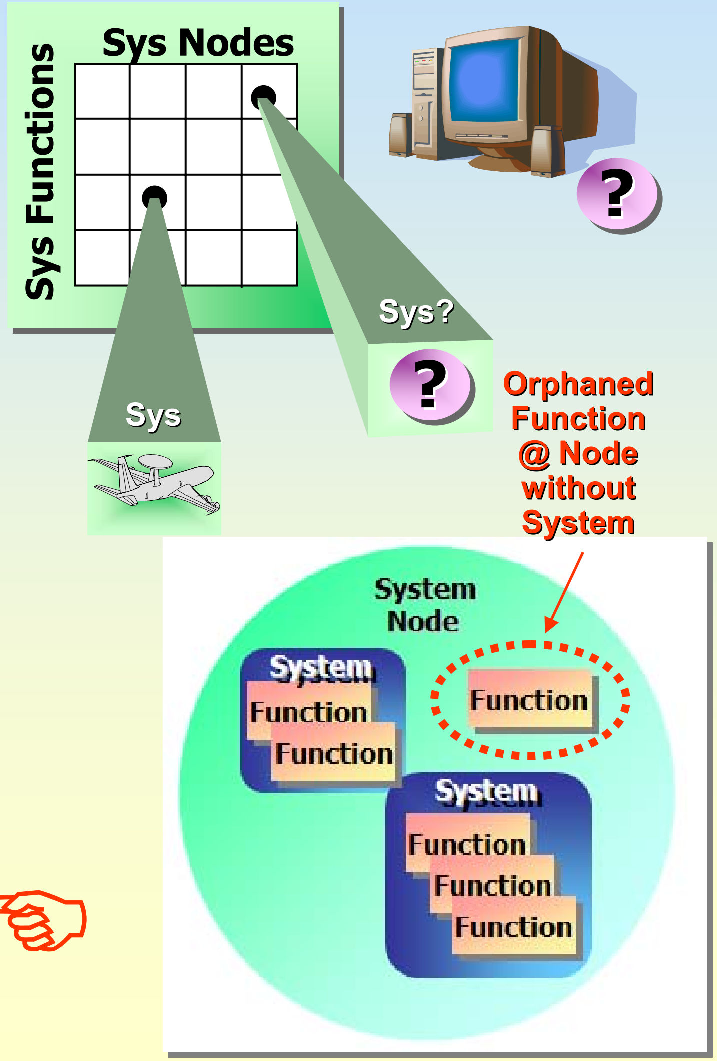
Mapping ADSM to DOTMLPF



“*Gap-Analysis*” for “*To-Be*” Architectures

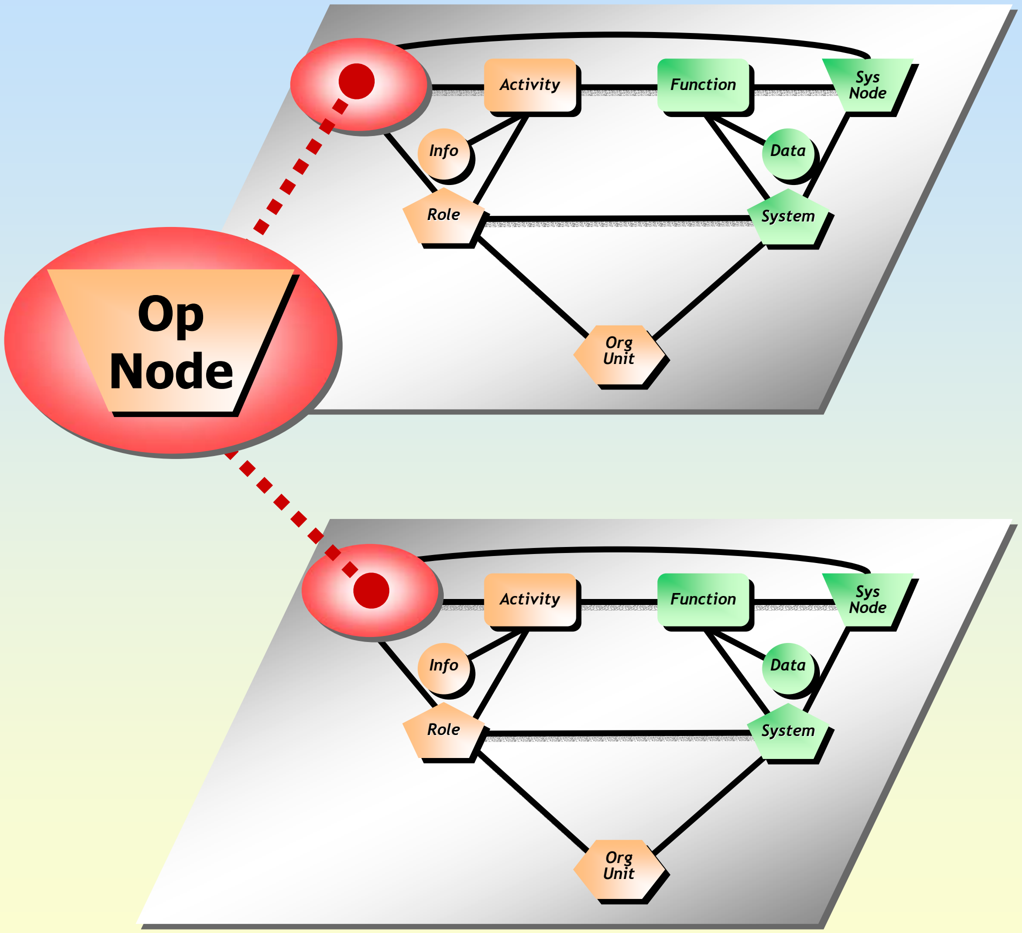






Activities Functions	Op Nodes Sys Nodes	Roles Systems	
?	☑	☑	Not Valid Must know Activities
☑	☑	?	**Most likely “gap-analysis”**
☑	?	☑	Possible “gap-analysis”
☑	?	?	Least likely

Analysis of Integrated Architectures Between Other Architectures - “*Seam Analysis*”



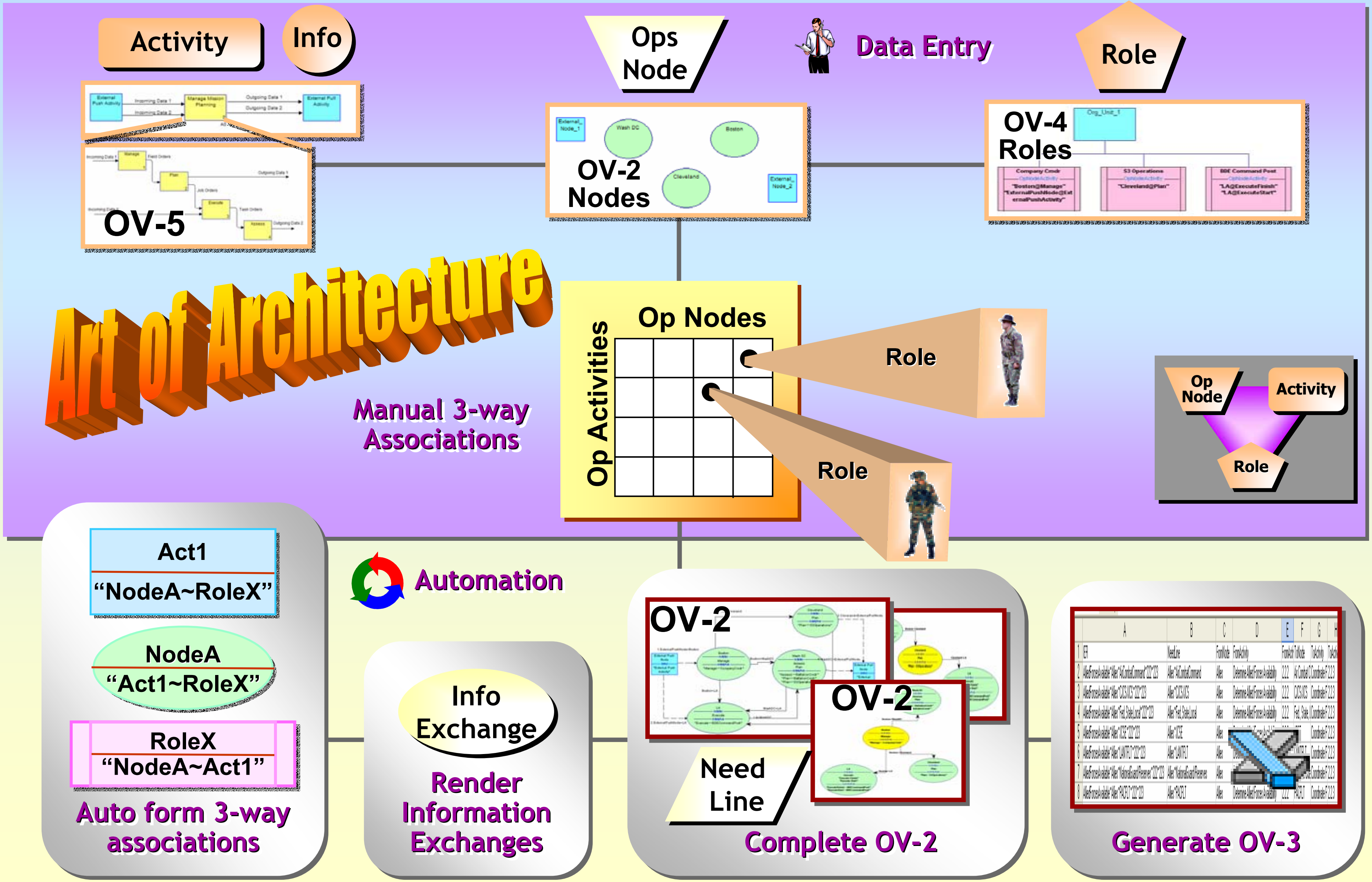
ONodeA – Act1 – SF1 – SNodeA
ONodeA – Act1 – SF2 – SNodeA
ONodeA – Act2 – SF3 – SNodeA
ONodeA – Act2 – SF4 – SNodeA

ONodeA – Act3 – SF5 – SNodeA
ONodeA – Act4 – SF6 – SNodeA
ONodeA – Act4 – SF7 – SNodeA
ONodeA – Act5 – SF8 – SNodeA

ONodeA – Act1 – SF1 – SNodeA
SF2 – SNodeA
Act2 – SF3 – SNodeA
SF4 – SNodeA
Act3 – SF5 – SNodeA
Act4 – SF6 – SNodeA
SF7 – SNodeA
Act5 – SF8 – SNodeA

Steps to an Integrated Operational Architecture

MITRE



Activity

Info

Ops Node

Data Entry

Role

OV-5

OV-2 Nodes

OV-4 Roles

Art of Architecture

Manual 3-way Associations

Op Nodes

Op Activities

Role

Role

Op Node

Activity

Role

Act1
"NodeA~RoleX"

NodeA
"Act1~RoleX"

RoleX
"NodeA~Act1"

Auto form 3-way associations

Automation

Info Exchange

Render Information Exchanges

OV-2

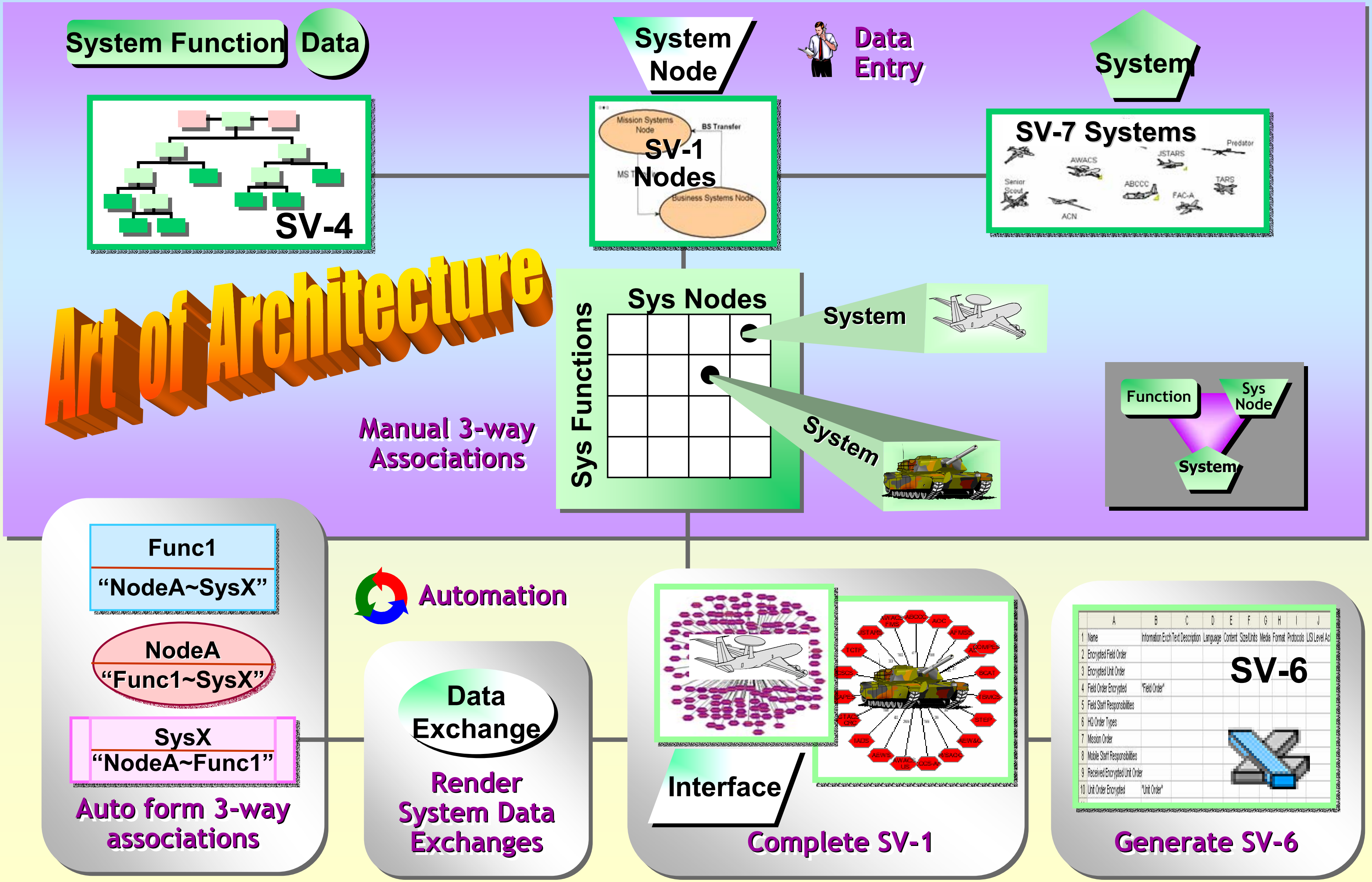
OV-2

Need Line

Complete OV-2

Generate OV-3

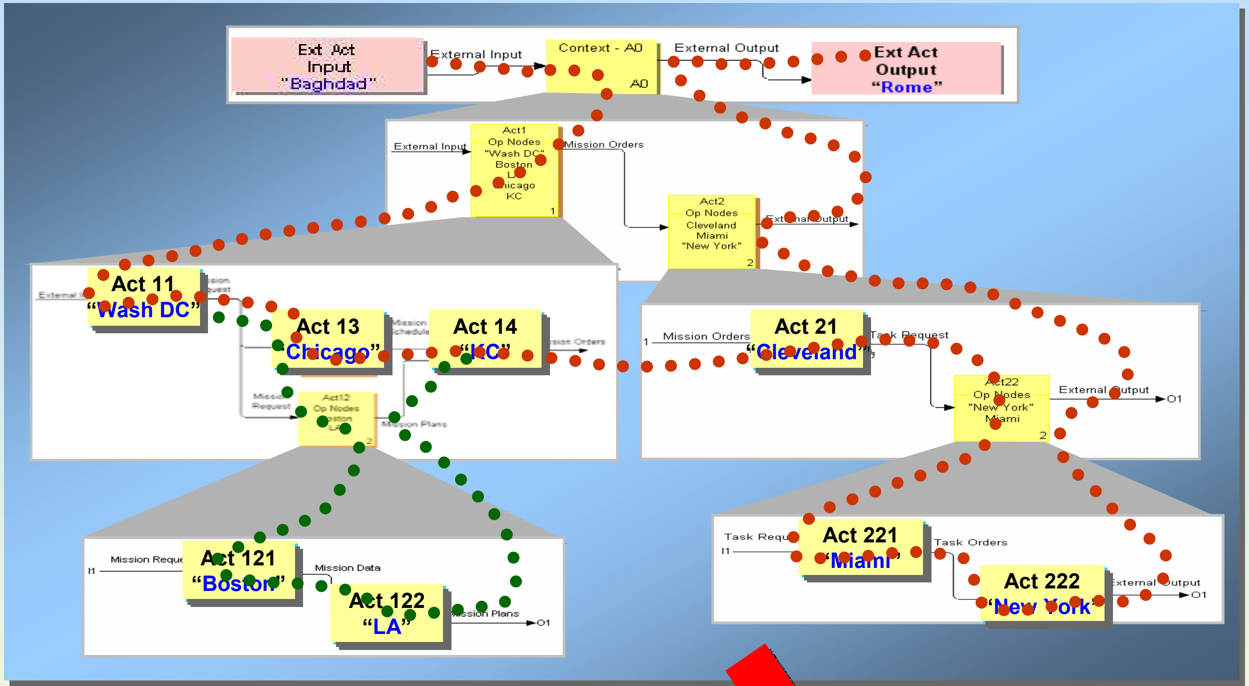
Steps to an Integrated Systems Architecture



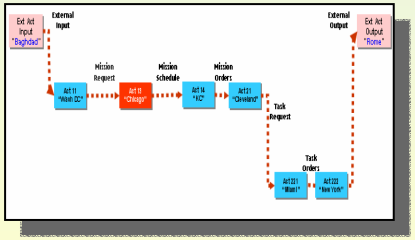
	A	B	C	D	E	F	G	H	I	J
1	Name	Information Exch	Text Description	Language	Content	Size/Units	Media	Format	Protocols	LISI Level Ac
2	Encrypted Field Order									
3	Encrypted Unit Order									
4	Field Order Encrypted	"Field Order"								
5	Field Staff Responsibilities									
6	HQ Order Types									
7	Mission Order									
8	Mobile Staff Responsibilities									
9	Received Encrypted Unit Order									
10	Unit Order Encrypted	"Unit Order"								

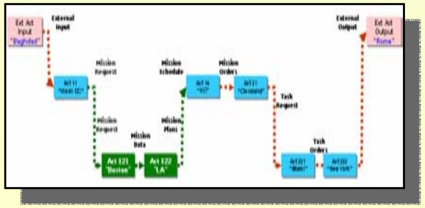
Chained *Leaf Activities* Produce Candidate Activity Thread (Scenario) Models Of Sequenced Actions

MITRE

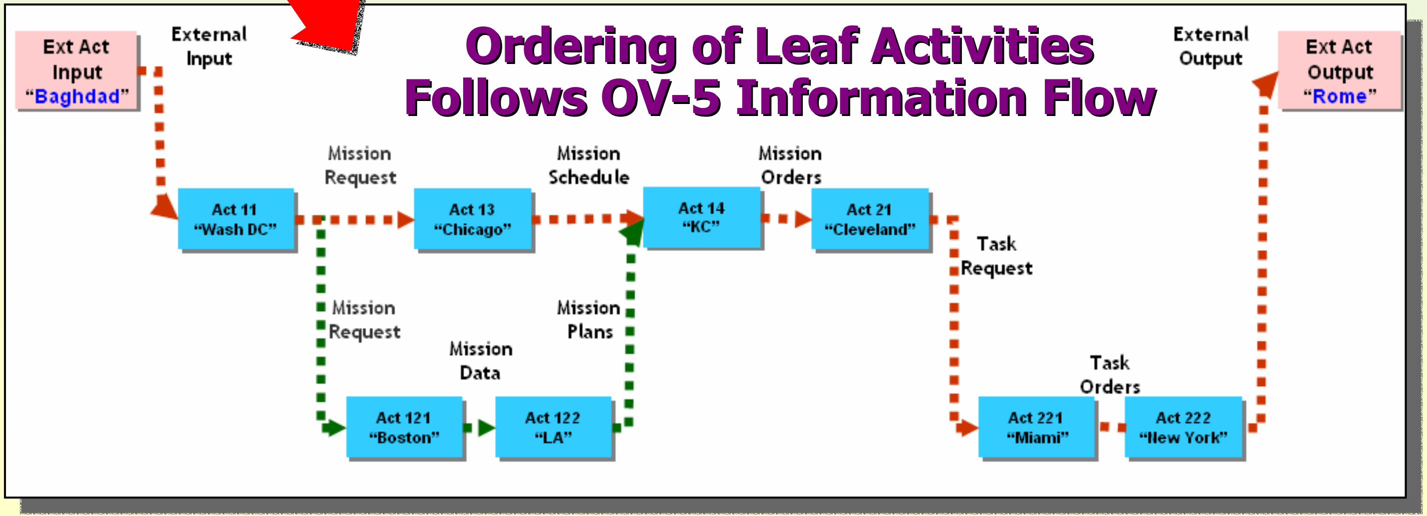


- External Activities/ Nodes
- Lowest activities in node tree chain
- No further decomposition
- Leaf activities signified by **Blue Boxes**
- OV-6 generation
- **Information Exchanges and Need Lines built only from Leaf Activities**
- ***Use Cases/System Functions***





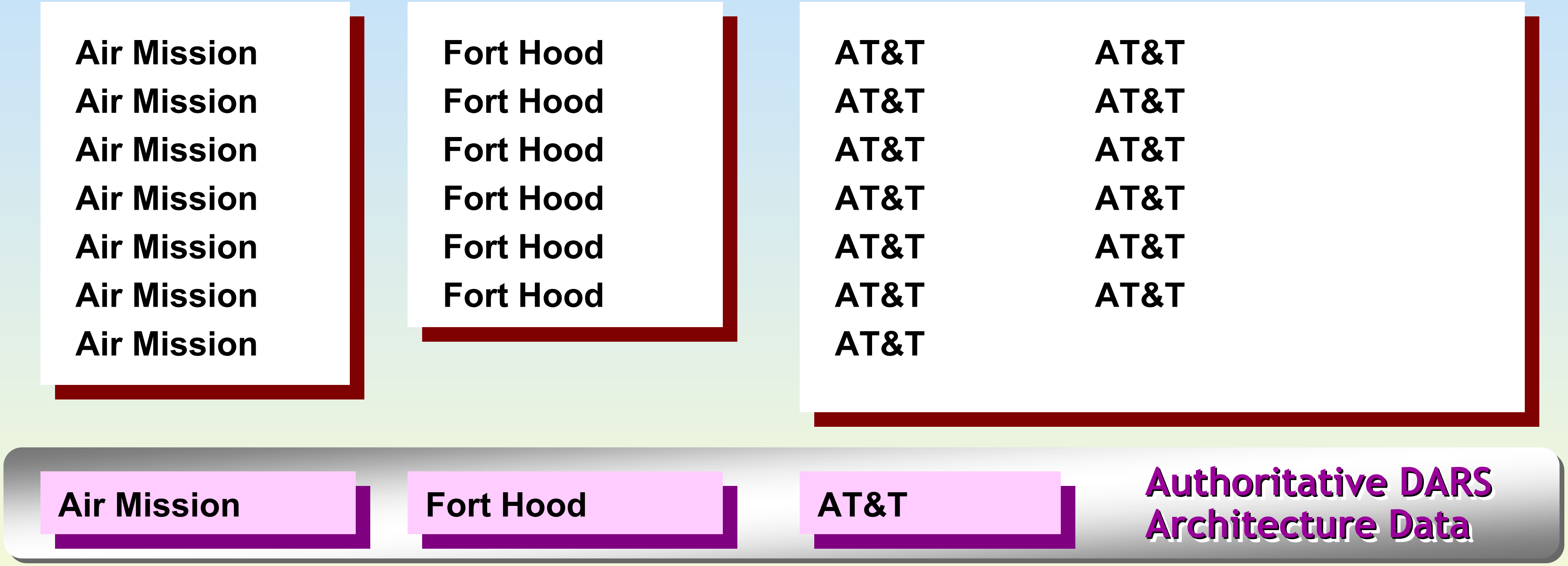
Ordering of Leaf Activities Follows OV-5 Information Flow



Data Cleaning: 1st Step in Architecture Development

MITRE

Turning *Unfriendly*, *Dirty* Data into *Friendly*, *Clean* Data*



Air Mission
Air Mission
Air Mission
Air Mission
Air Mission
Air Mission
Air Mission

Fort Hood
Fort Hood
Fort Hood
Fort Hood
Fort Hood
Fort Hood

AT&T
AT&T
AT&T
AT&T
AT&T
AT&T
AT&T

AT&T
AT&T
AT&T
AT&T
AT&T
AT&T

Air Mission

Fort Hood

AT&T

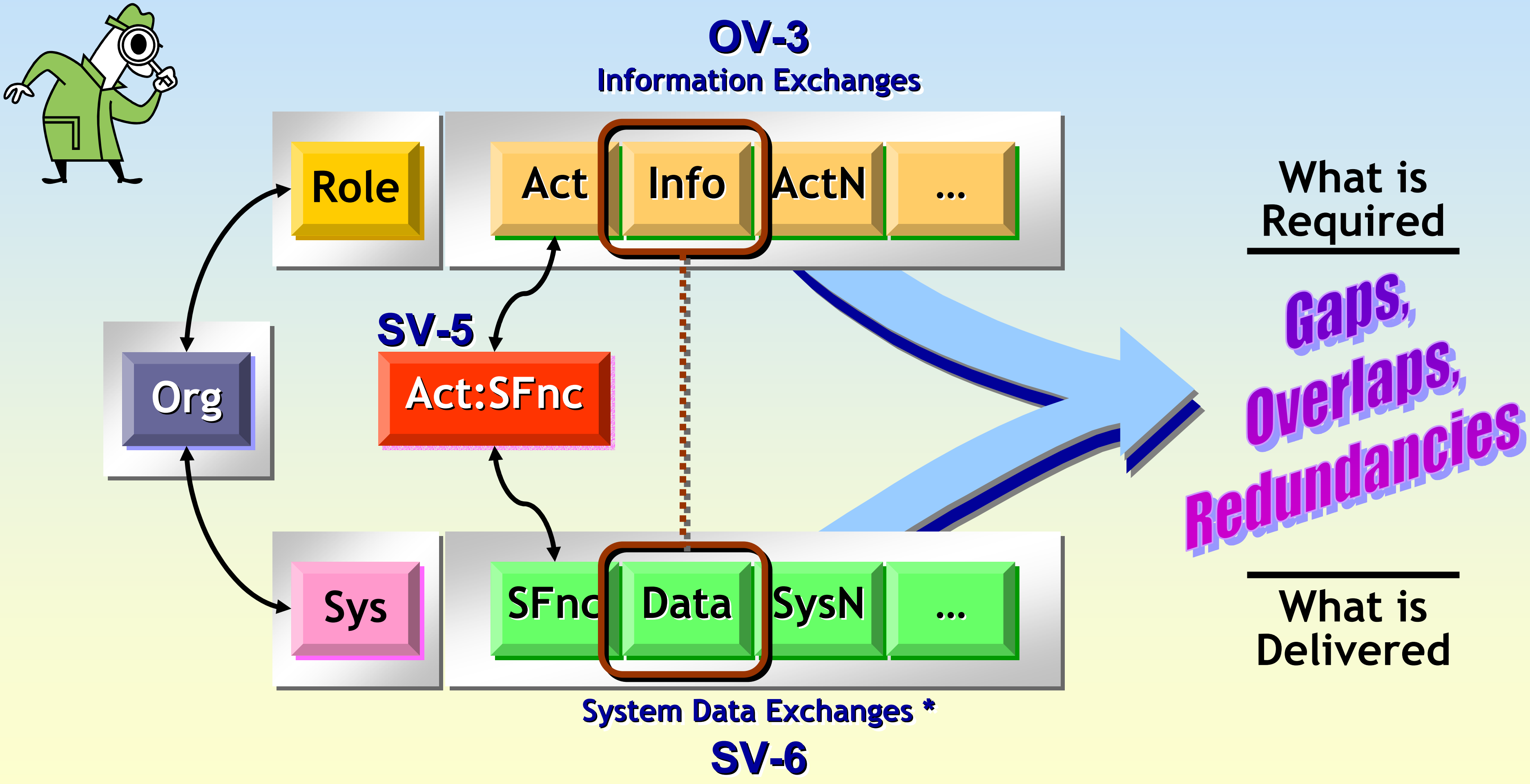
Authoritative DARS Architecture Data

Synonyms
different names mean same things
('location' and 'loc', 'Target' and 'tgt')

Homonyms
same name means different things ('mission', 'tank', 'mustang')

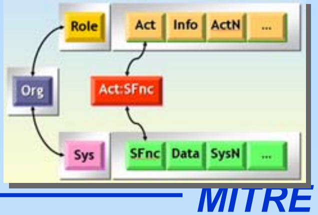
*Cleaning a manual operation

Architecture Data Mining with Extended OV-3 & SV-6



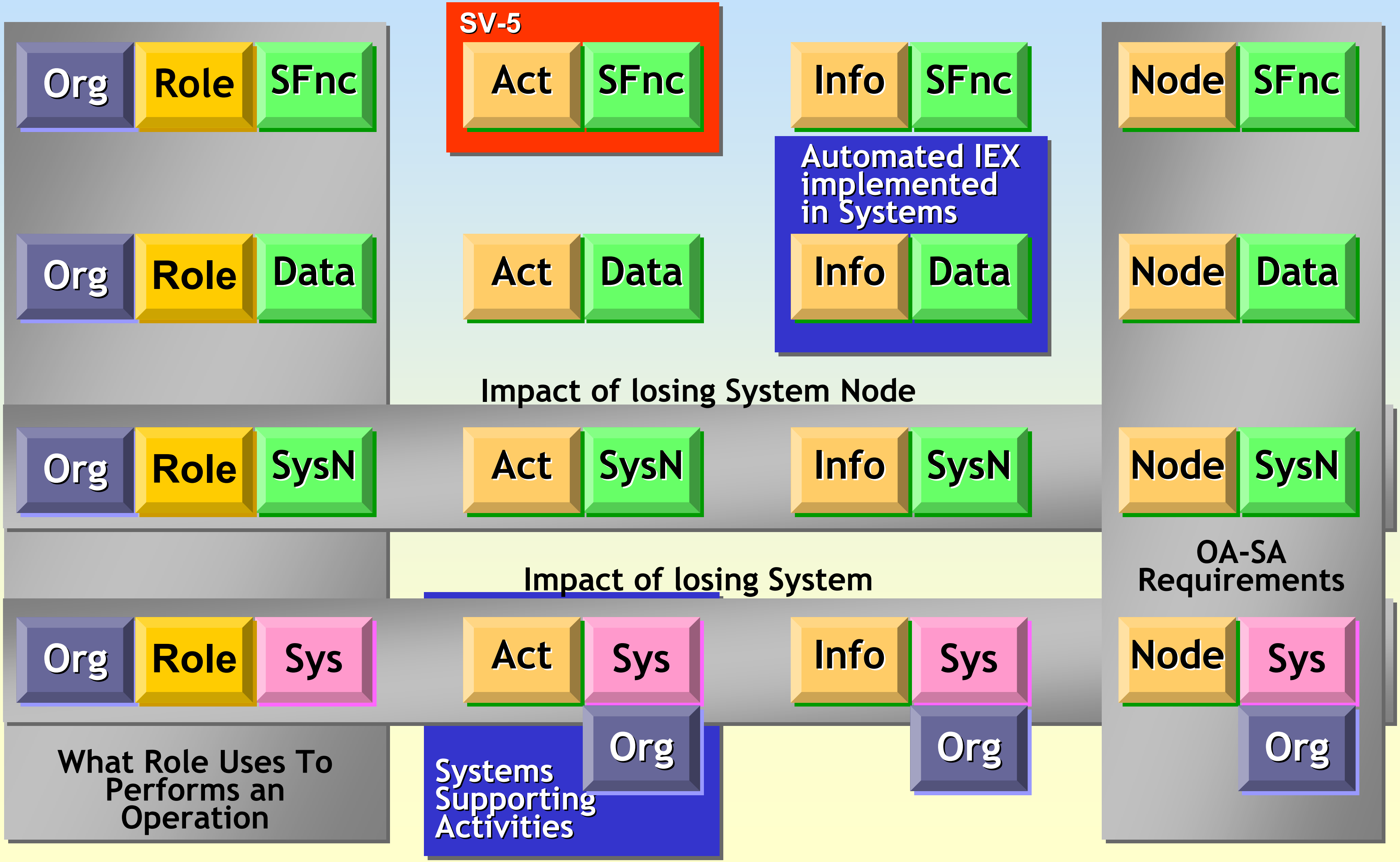
* Automated information exchanges (from OV-3) implemented in Systems

OV-3 & SV-6 Relationship Analysis



MITRE

What if? If What?



SV-5

Org Role SFnc

Act SFnc

Info SFnc

Node SFnc

Automated IEX implemented in Systems

Org Role Data

Act Data

Info Data

Node Data

Impact of losing System Node

Org Role SysN

Act SysN

Info SysN

Node SysN

OA-SA Requirements

Impact of losing System

Org Role Sys

Act Sys Org

Info Sys Org

Node Sys Org

What Role Uses To Performs an Operation

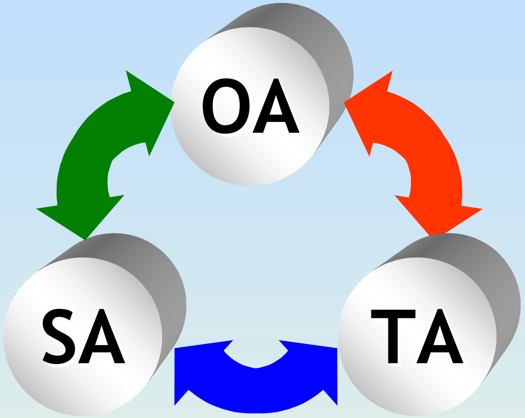
Systems Supporting Activities

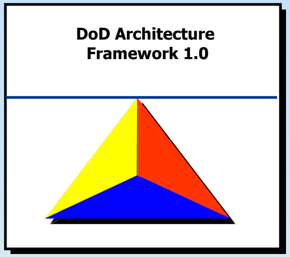
Transition to Executable Architectures

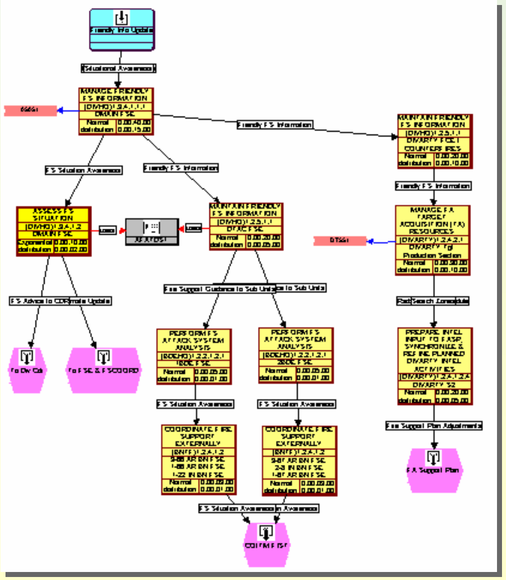
Reconfigure three DODAF Views

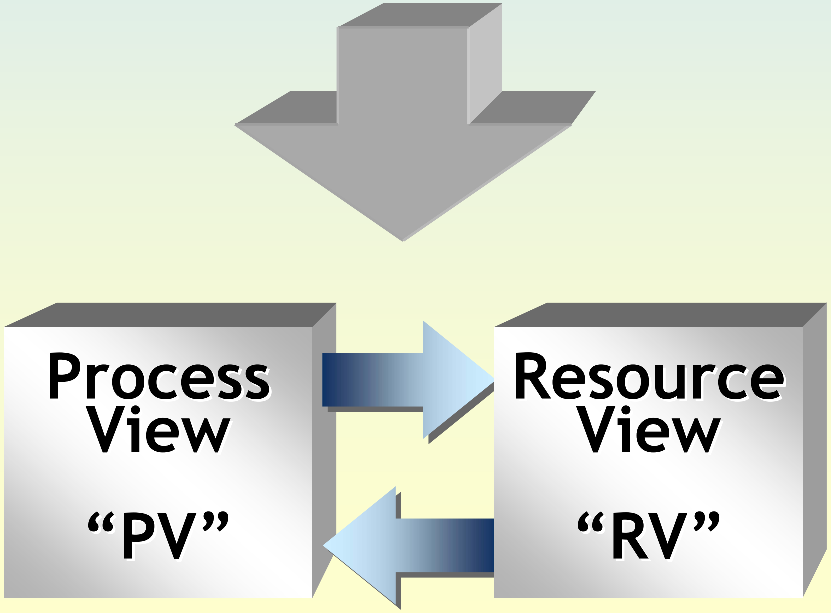
into

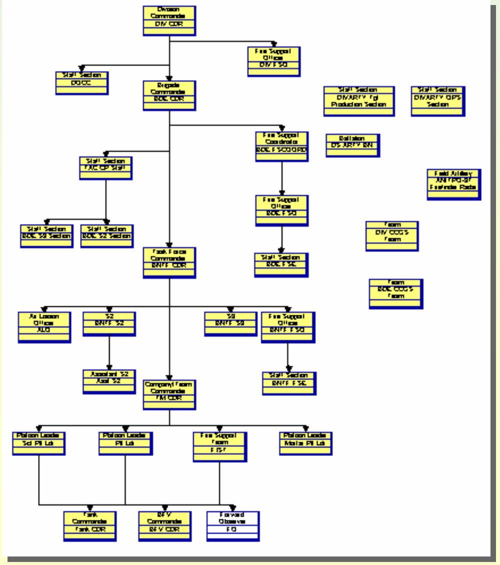
Process & Resource Views









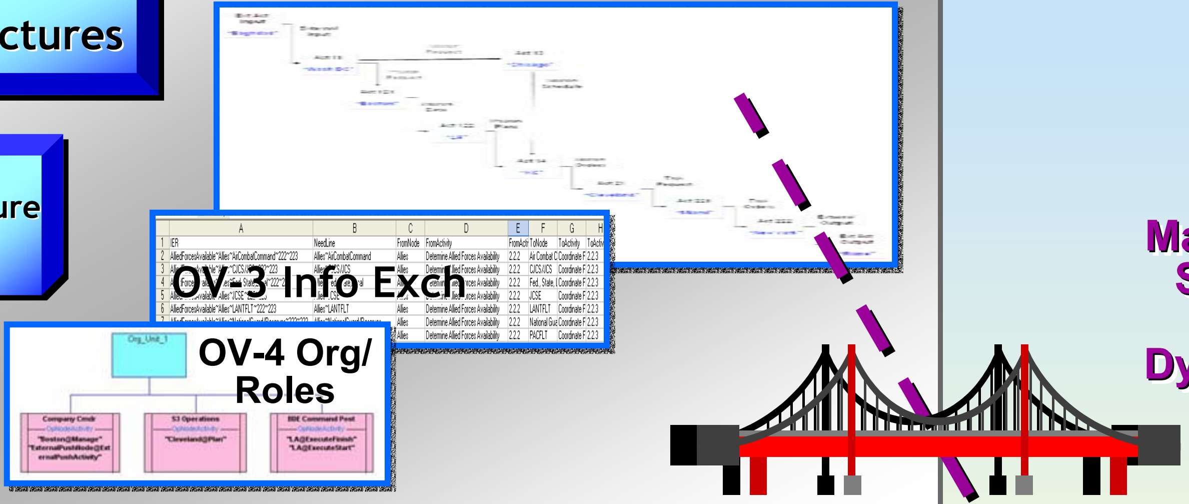


Transformation to Dynamic Process Models

Integrated Architectures

Architecture Tools

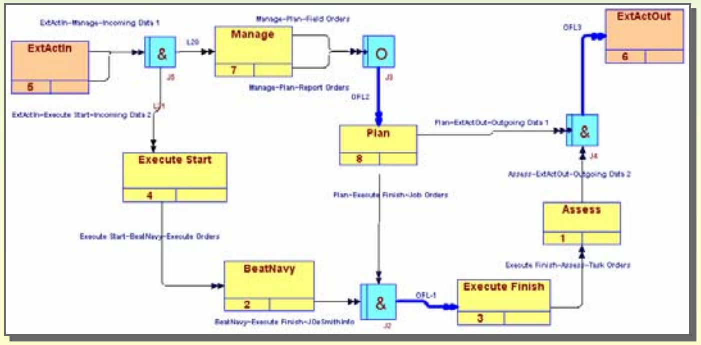
OV-5 Leaf Activities Rearranged to Match OV-2



OV-3 Info Exch

OV-4 Org/ Roles

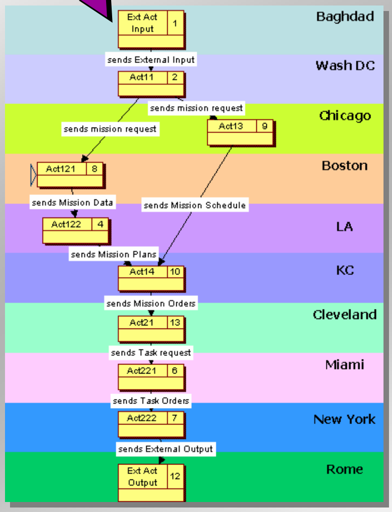
Mapping Static -to_ Dynamic


ExtActIn
5
&
J5
L20
Manage
7
O
J3
OFL2
ExtActOut
6
OFL3
Plan
8
&
J4
Execute Start
4
Assess
1
BeatNavy
2
&
J2
OFL-1
Execute Finish
3
ExtActIn-Manage-Incoming Data 1
Manage-Plan-Field Orders
Manage-Plan-Report Orders
ExtActIn-Execute Start-Incoming Data 2
Plan-ExtActOut-Outgoing Data 1
Assess-ExtActOut-Outgoing Data 2
Plan-Execute Finish-Job Orders
Execute Start-BeatNavy-Execute Orders
Execute Finish-Assess-Task Orders
BeatNavy-Execute Finish-JDeSmithInfo

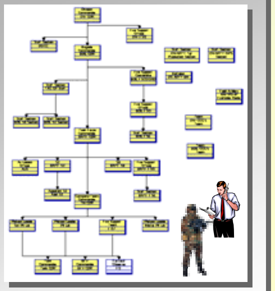
Generated OV-6a

Executable Architectures

Executable Modeling Tools



+



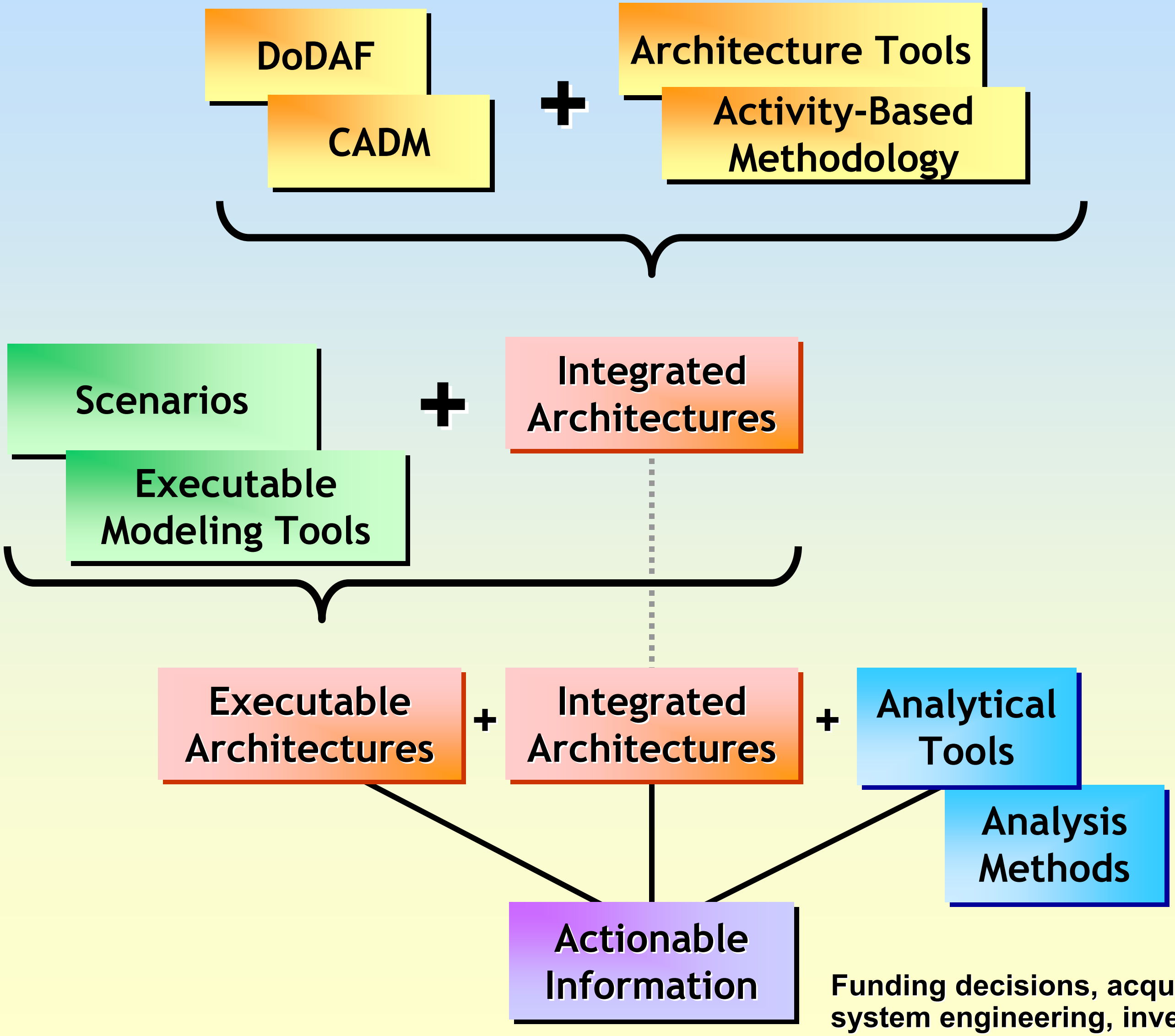
What Are Executable Architectures?

- Static Operational Models only show that Activities "*must be capable of*" producing and consuming Information
  - ? No details on event sequencing
  - ? No details on how or what conditions information is produced/ consumed
  - ? No details on producers/ consumers themselves or other resources used

- Dynamic (over time) Executable Architecture Models go beyond "*must be capable of*" – "**WHEN**"
  - ✓Defines precise sequential/ concurrent event model
  - ✓Defines precisely under what conditions Information is produced/ consumed
  - ✓Defines details on producers/ consumers (number and process ordering) and other resources (when [not] available)

Dynamic model of Activities and their event sequencing performed at Operational Nodes by Roles (within Organizations) using Resources (Systems) to produce and consume Information

Summary



Guidance + Compliant Tools and Methodology Render <u>Integrated Architectures</u>

Integrated Architectures + Simulation Tools and Scenarios (context) Render <u>Executable Architectures</u>

Integrated Architectures + Executable Architectures + Analytical Tools and Methods Render <u>Quantative Actionable Information</u>

Funding decisions, acquisitions, system engineering, investment strategy,…