

Building a Unified System Development Environment

CAE OPTIONS FOR NEW VEHICLE SYSTEMS

A partnership with the

dti

Department of Trade and Industry

Funded under the Commercial Aerospace Research And Demonstration (CARAD) programme

- Three year programme valued at £2 million
- Advancing web technology within the aerospace design process
- Innovative control system design method
- Computer-based framework supporting concurrent engineering
- Advanced database concepts
- Distributed platform - independent computing


Innovation
Chairman's Awards
For Innovation



1998 & 1999
AWARD
WINNER



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Nationaal Lucht- en Ruimtevaartlaboratorium
National Aerospace Laboratory NLR

BAE SYSTEMS



STEP AP233 Systems Engineering

Experience from a Pilot Implementation

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STEP for Aerospace workshop
NASA/JPL, 25-27 January 2000



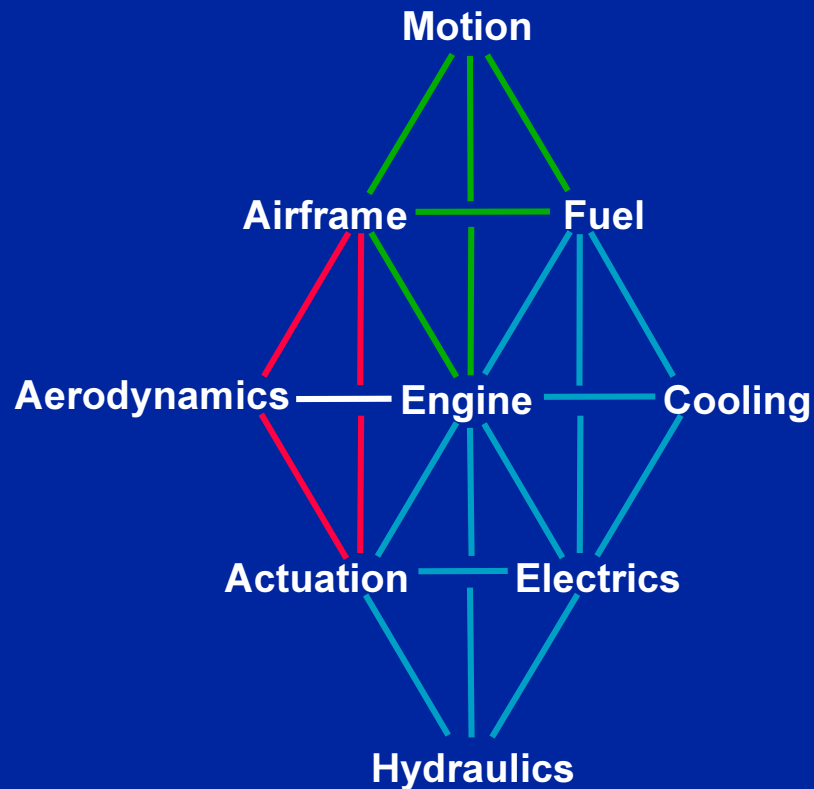
Presentation Contents

- **Application - Vehicle Management System**
- **STEP AP233 Use & Experience**
- **Systems Engineering Environment**
- **Outlook**

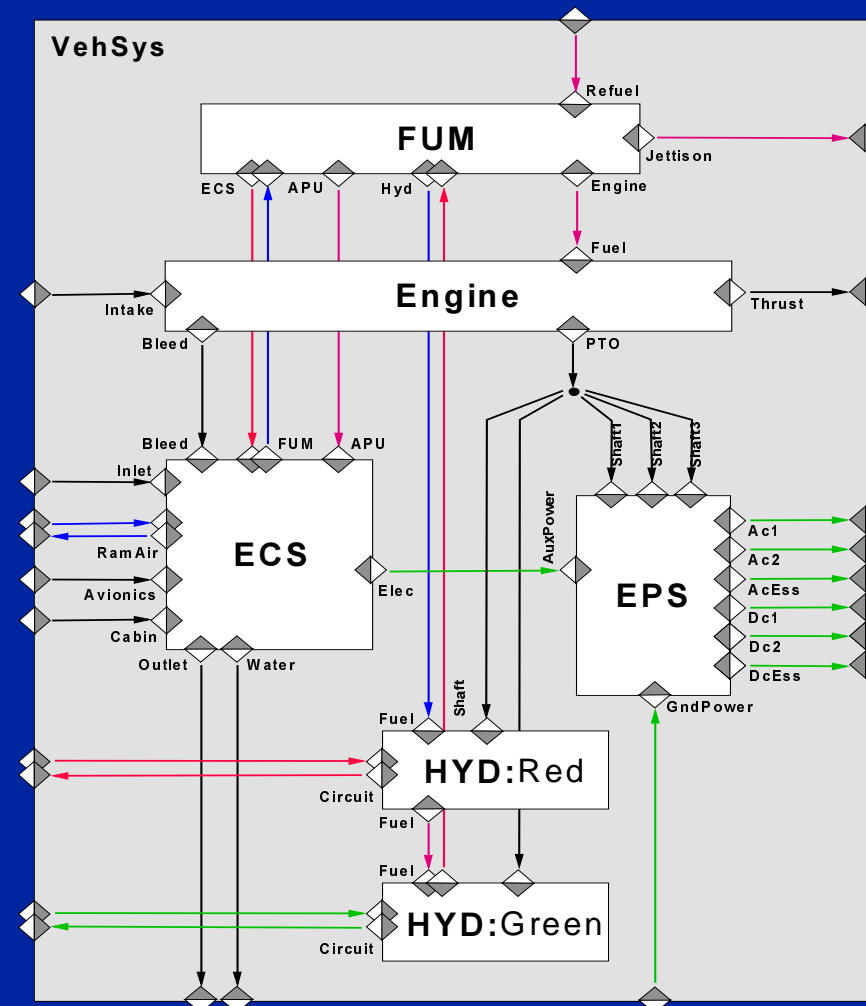
Questions? Afterwards...



Application Vehicle Management System

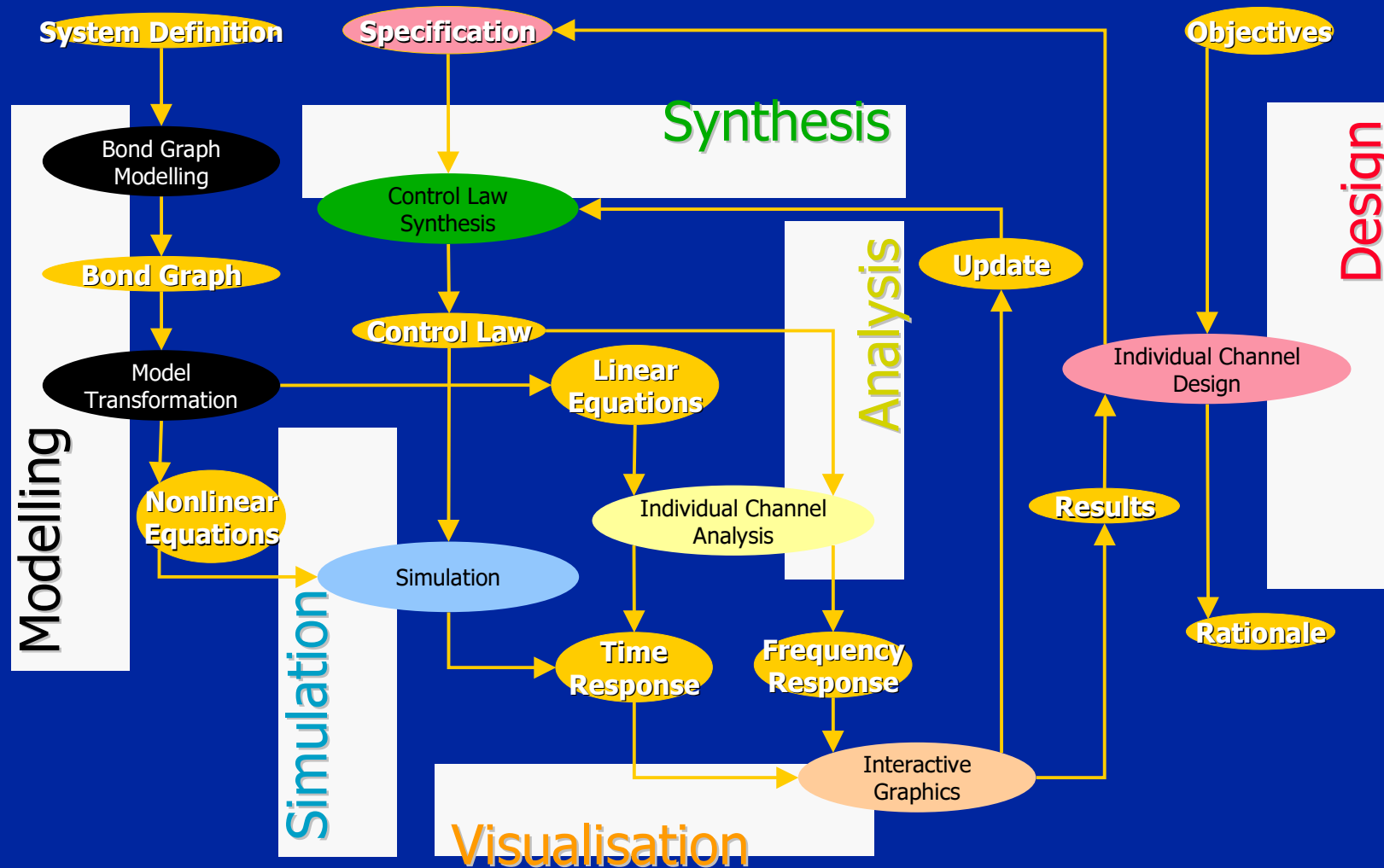


- AeroPropulsive Interaction
- Vehicle Systems Integration
- AeroServoElastic (ASE) Interaction
- Inertial Dynamics





Application Process Overview





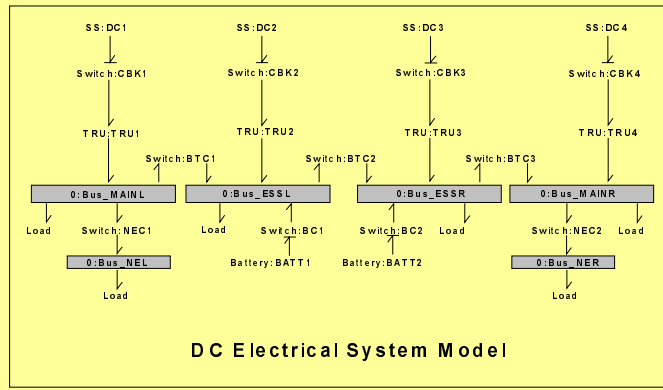
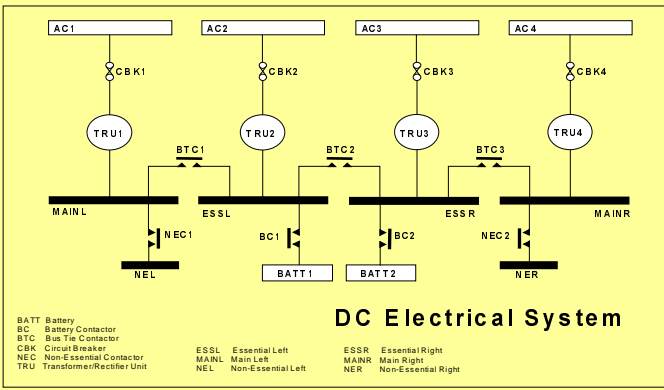
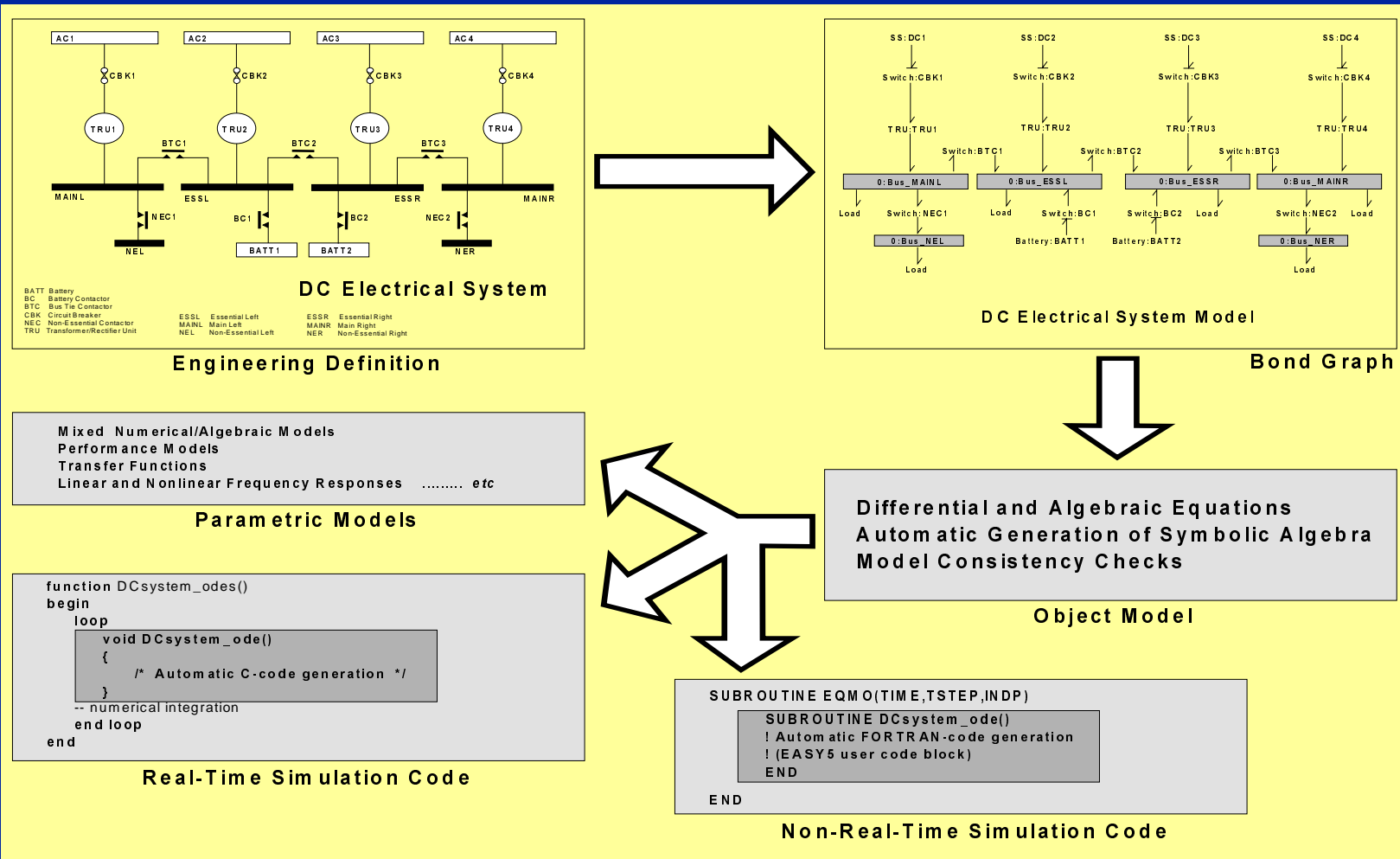
Application

Engineering Process Issues

- **Systems Integration**
Complex Interaction, Functional Diversity, Large Scale
- **Consistent Product Model**
Multiple Notations/Views, Unified Models, Data Sharing
- **Network Computing**
Distributed Resources, Dissimilar Operating Systems
- **Process Management**
Traceability, Process State, Multi-disciplinary Teams



AP233 Dynamic System Models



Mixed Numerical/Algebraic Models
Performance Models
Transfer Functions
Linear and Nonlinear Frequency Responses etc

Parametric Models

```
function DCsystem_odes()
begin
loop
void DCsystem_ode()
{
/* Automatic C-code generation */
}
-- numerical integration
end loop
end
```

Real-Time Simulation Code

Differential and Algebraic Equations
Automatic Generation of Symbolic Algebra
Model Consistency Checks

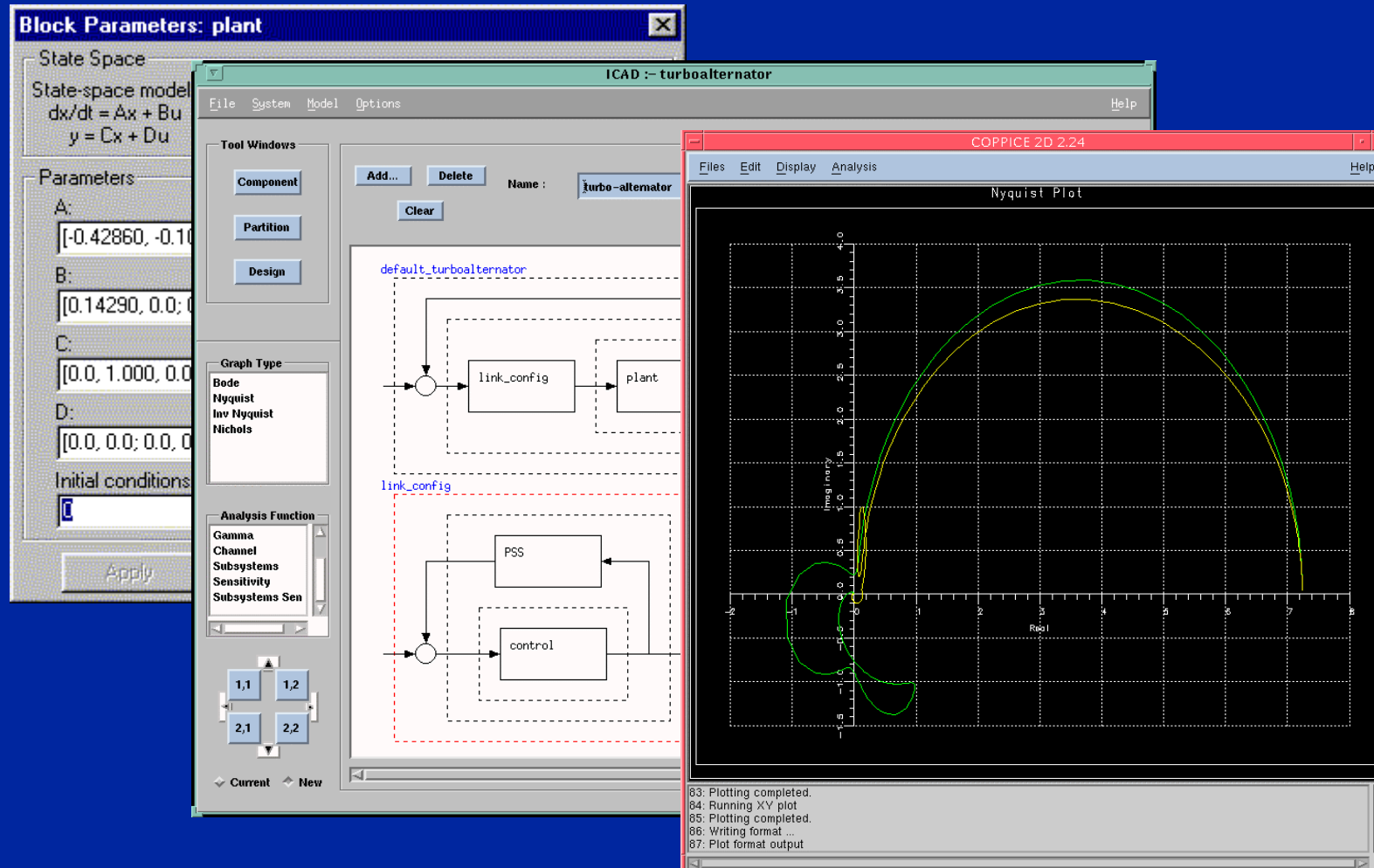
Object Model

```
SUBROUTINE EQMO(TIME,TSTEP,INDP)
SUBROUTINE DCsystem_ode()
! Automatic FORTRAN-code generation
!(EASY5 user code block)
END
END
```

Non-Real-Time Simulation Code



AP233 Control Systems Engineering





AP233

Main usage of AP233 - draft 1

- **Units of Functionality applied**
 - functions: definition, instances, io_port
 - flows, bindings
 - data types: definition, instances
 - visual presentation
- **Schema adaptations**
 - data types: matrix, transfer function, state space, ...
 - parameters, parameter ports
 - domain-dependent units & scaling
 - a-causal modelling → generic port and link
 - physical modelling



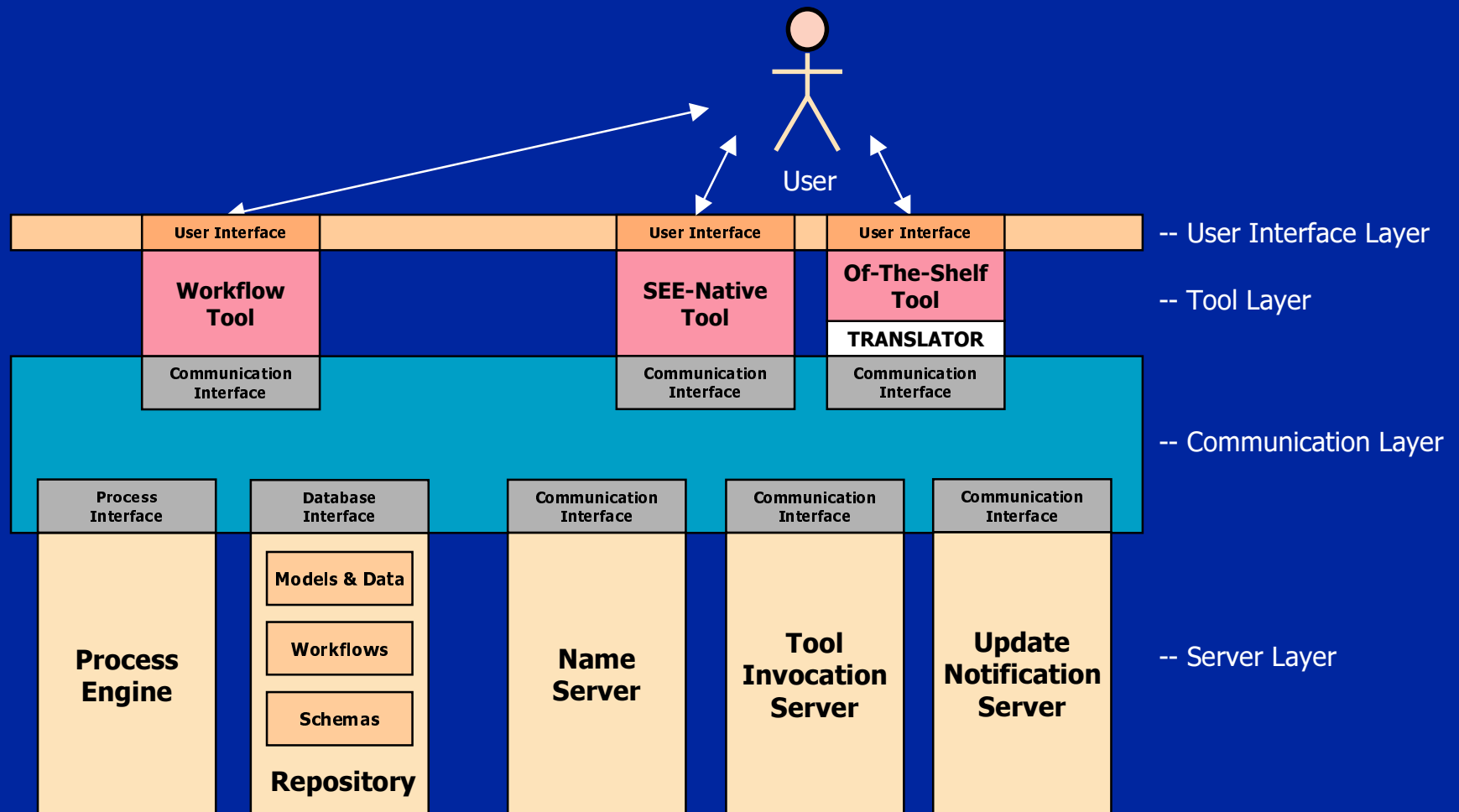
AP233

Required Extensions

- **Component definition language**
 - equations (formulas), tables, ...
- **Visual presentation**
 - system schematics, including system dynamics info
 - graph plots: multi-dimensional
 - user interfaces
- **Configuration management, PDM-harmonised**
- **Executable context (scenarios), re-usable**
- **Multi-level model details**



SEE Systems Engineering Environment

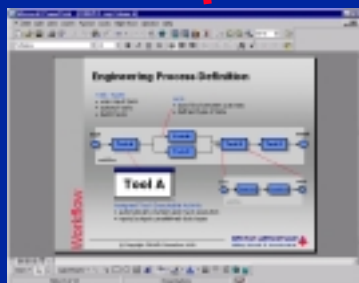
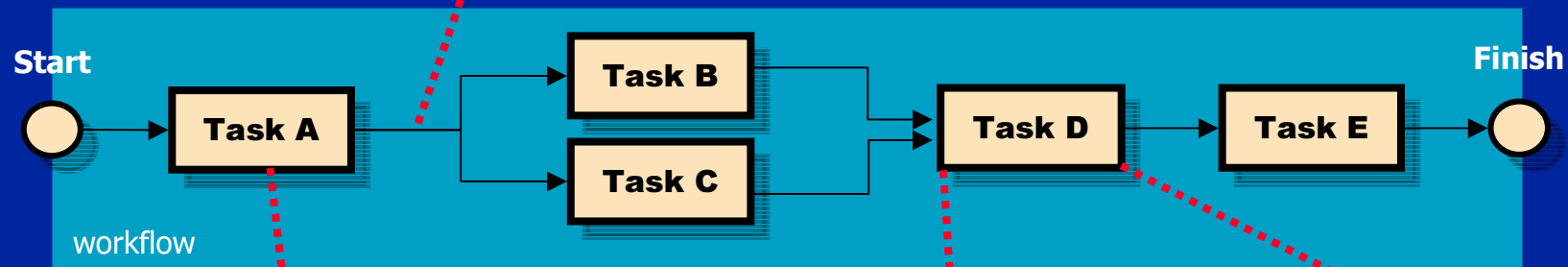




SEE Engineering Workflow - Definition

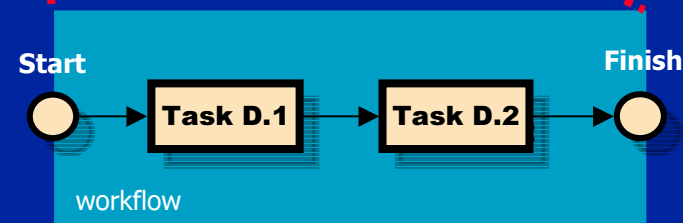
Link:

- data flow between activities
- defined type of data from AP233



Assigned Tool: Executable Task

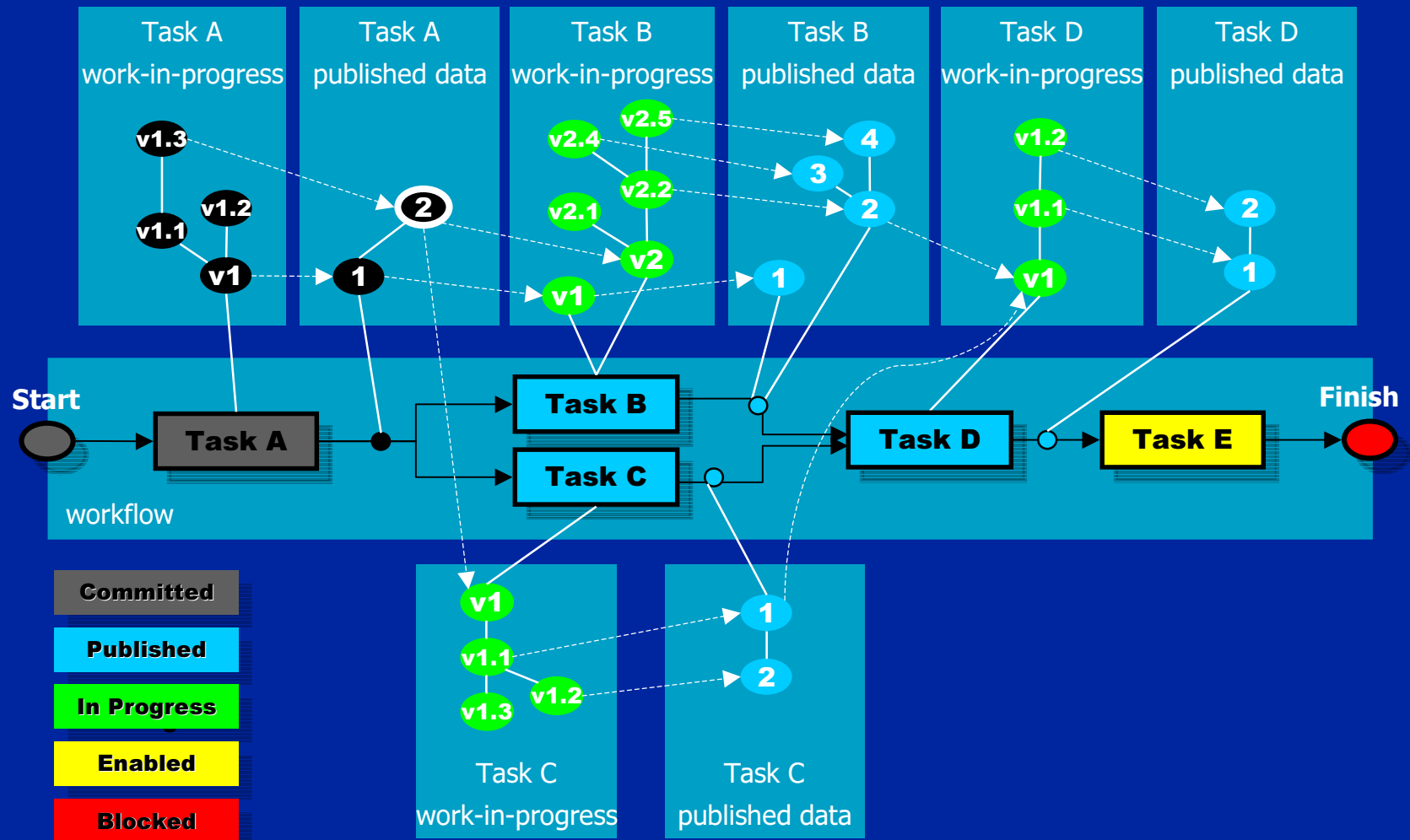
- automatically started upon task execution
- inputs/outputs predefined data types



Hierarchy: Task Decomposition



SEE Engineering Workflow - Execution





SEE **Benefits**

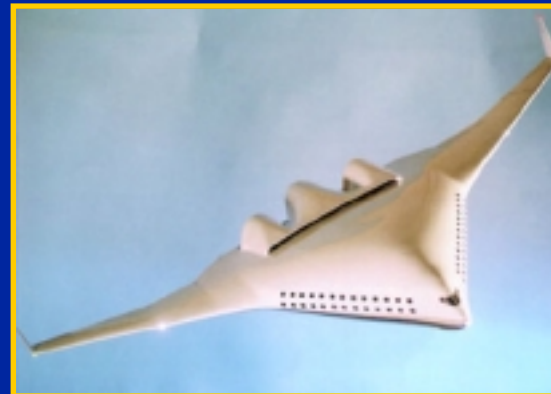
- **On-line process state, always up-to-date**
- **Traceability, process history**
- **No low level tool / data handling**
- **Knowledge capture, best-practice templates**
- **AP233 neutral format for dynamic system models**
- **Shared product model, managed configuration**
- **Distributed computing facilities as one computer**



Outlook

Collaborative Engineering

- **Visual-iSE (Visual integrated Systems Engineering)**
 - computer-based systems engineering infrastructure
 - AP233, shared repository, engineering workflow
- **Platform for:**
 - Concurrent Engineering in Aircraft Development
 - Multi-disciplinary Optimisation, Blended Wing Body





Outlook **AP233 Development**

- Systems engineering integrating all STEP APs???
- Involve all stakeholders



PARTICIPATE!!!

- Generate User Requirements
- Apply & Test AP233
- Feedback Experience