Solving Power System Analysis Problems Using Modern Software Approach

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New advance in computer hardware and software technologies is enabling new ways to design power system analysis software to implement the existing and future models/algorithms in a flexible and extensible way to quickly evolve and adapt to future changes.

“Changing is the only constant” - Bill Gate
Setting the Stage

- **OFP models and algorithms**

- **Focus - Computer implementation of the model/algorithm**
  - Conceptual, architecture high-level
  - Common software concept and methodology
  - In-scope
    - Software architecture
    - Software flexibility and extensibility
    - Software maintainability
  - Out-scope
    - Applicability, accuracy and stability of the models/algorithms
    - Computation efficiency
Advances in Information Technology

- Network (10G pipe, 10M message/sec)
- Multi-processor, multi-core hardware architecture
- Virtualization technology
  - Virtual machine technology (Java, C#)
  - Virtual operating system (VMWare, Amazon EC2 …)
- Software development
  - Open-source – most advanced tools available for ordinary developers
  - Coding vs integration
  - MDA : Model Driven Application development
    - Code generation
Software Architecture – Then and Now

Traditional Approach

Application Suite

Component Approach

Extensions

Core

The Eclipse Project

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Model-based Approach

- **Y-matrix – a conceptual model**
  \[ [V] = [Y] \times [I] \]

- **Computer implementation model**
  - Fortran style - One or two-dimensional array (50K-bus version)
  - Bus/Branch Model approach
    - Apply to sparse matrix
    - Code generation (MDA)

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Grid Computing

- Simulation engine runs as a service
- Simulation algorithm implementation multi-thread safe
- Simulation job serialized/de-serialized as XML document
- OS neutral language (Java) preferred
Cloud computing – in the process to become mature

Power system – cloud of generation resources
The InterPSS Project

- **InterPSS**
  - Internet Technology-based Power System Simulation Software
  - Apply modern software approach to solve power system analysis problems
  - Java is chosen as its programming language

- **Open architecture**
  - Components from other system could be integrated into InterPSS
  - InterPSS components could be taken out and integrated into other systems
A good architecture is not there is nothing to add, rather nothing could be taken away

**InterPSS Core Engine**

- Generic Power Network (Y-matrix) Solver
- + IoC Container (Spring Framework)
- + Default (replaceable) Algorithm Implementations

Component Approach

InterPSS Systems
“Simple yet Powerful”

- **Simple – a generic Y-matrix solver**
  - Reuse – any Y-matrix based algorithm
  - Model-based approach
    - 70% of InterPSS core engine code generated by computer
  - Multi-thread safe

- **Powerful – extension through IoC injection**
  - IoC (Inversion of Control)

- **Based on the same core simulation engine**
  - InterPSS desktop application
    - ALoadflow, DC Loadflow/Sensitivity Analysis, Short Circuit, Transient Stability
  - InterPSS Grid Computing Edition
  - InterPSS Cloud Edition
  - InterPSS Interactive for Power Trading

_InterPSS Systems_
InterPSS Project Info

- [http://community.interpss.org](http://community.interpss.org)
- Started 2005
- Volunteers in US, Canada, China
- Open and free for any purpose
Summary

- **Fundamental changes in software industry over the last 30 years**
  - Software runtime environment
  - Software development methodology

- **Smart grid needs support by “smart” power system analysis software**
  - Modern software approach
  - Valuable lessons
    - Through the InterPSS project.
    - Openly shared (http://community.interpss.org)