EPRI | ELECTRIC POWER RESEARCH INSTITUTE

CIM for Dynamics

Pat Brown

Senior Project Manager, IntelliGrid Program

CIM Users Group

October 23, 2012

CIM for Dynamics

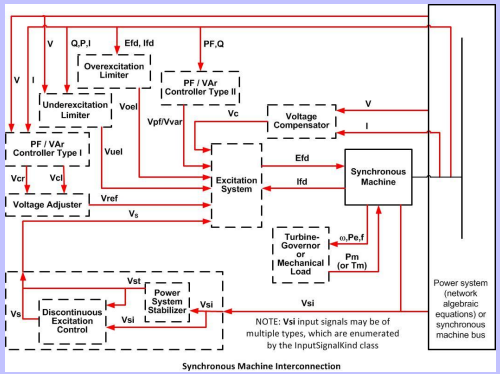
- What is “Dynamics”?
  - Modeling of transient (sub-cycle) behavior of generators, motors and loads
- Why extend the CIM to cover it?
  - To share models defined for use by one transient analysis application with another
  - To allow large transmission system coordinators (ISOs) to combine models defined by member transmission system operators

CIM for Dynamics

- Dynamic Behavior Modeling
  - A standard way of modeling behavior has evolved starting in mid-1960s
  - IEEE has defined over 100 standard behavior models
  - Other entities (IEC, equipment manufacturers, WECC, MMWG, ENTSO-E) have also contributed standard, or defacto standard, models

CIM for Dynamics

- Standard Dynamic models are related to ConductingEquipment



Synchronous Machine

Mechanical Load Dynamics

Asynchronous Machine Dynamics

Asynchronous Machine

Load Aggregate

Load Dynamics

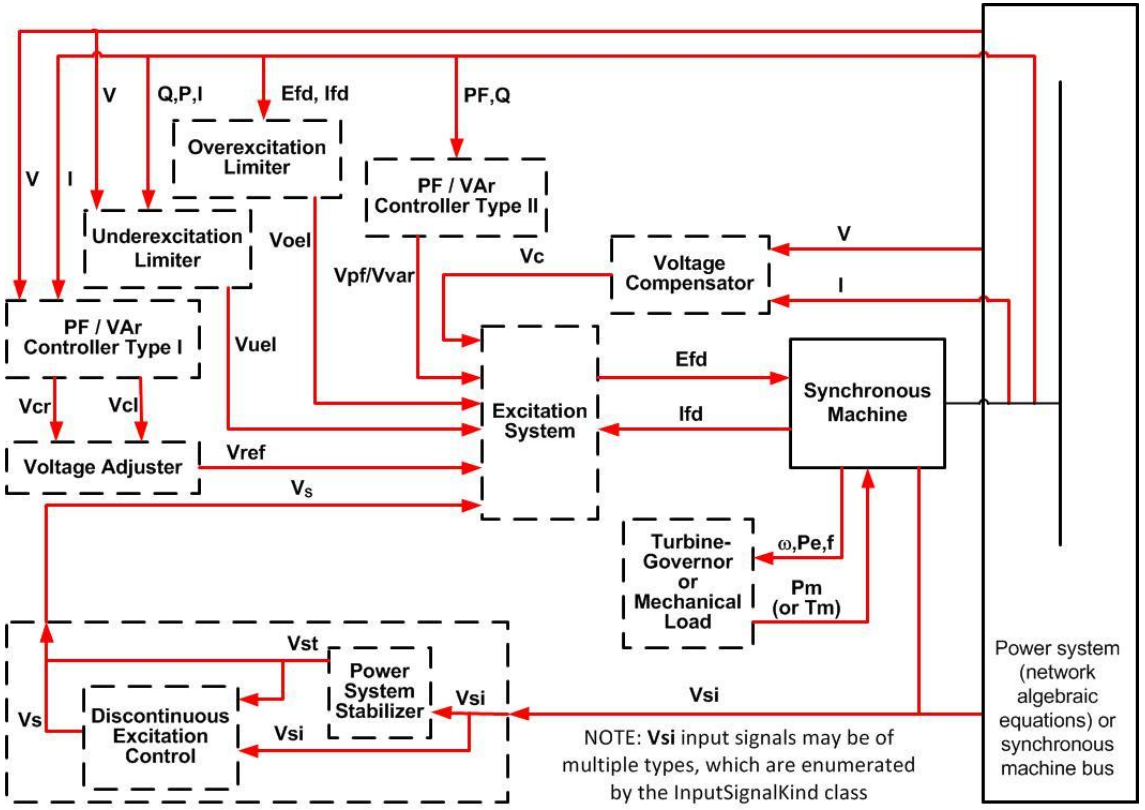
Energy Consumer

Dynamics

Wires

CIM for Dynamics

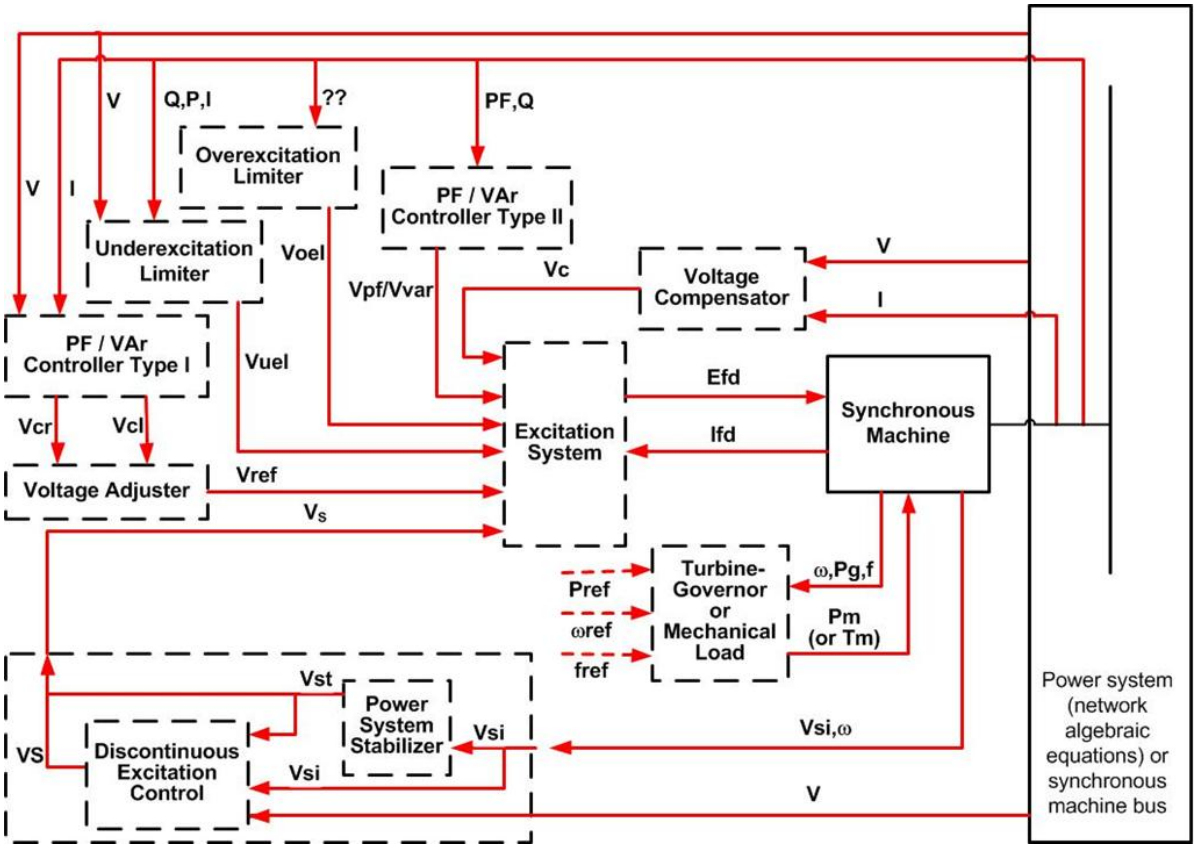
- Standard Dynamic models are comprised of:
  - **dynamic function blocks** performing standard types of functions *(the boxes)*
  - combined in **standard interconnection patterns** *(red arrow output/input relationships between function blocks)*



Synchronous Machine Interconnection

CIM for Dynamics

- Transient study applications provide starting inputs and then iteratively execute the model (the function blocks connected according to the interconnection pattern), creating a model of behavior over time



CIM for Dynamics

- Function blocks
  - Are “black boxes” - representing piece of self-contained dynamic behavior
  - Include:
    - Synchronous Machine (Generator or Motor)
    - Asynchronous Generator (Generator or Motor)
    - Voltage Compensator
    - Exctation Limiters (Over and Under)
    - PFVArControllers (Type I and Type II)
    - Voltage Adjuster
    - Excitation System
    - Turbine-Governor
    - Power System Stabilizer
    - Discontinuous Excitation System Control

CIM for Dynamics

- Function blocks
  - Have standard inputs and outputs and standard initialization assumptions, like these for an Excitation System

Inputs:

Name	*Description*
Vc	Compensated generator terminal voltage
Vref	Voltage reference
Ifd	Generator field current
Vs	Power system stabilizer (PSS) output
Voel	Overexcitation limiter output
Vuel	Underexcitation limiter output

Outputs:

Name	*Description*
Efd	Generator field voltage

Initialization Inputs:

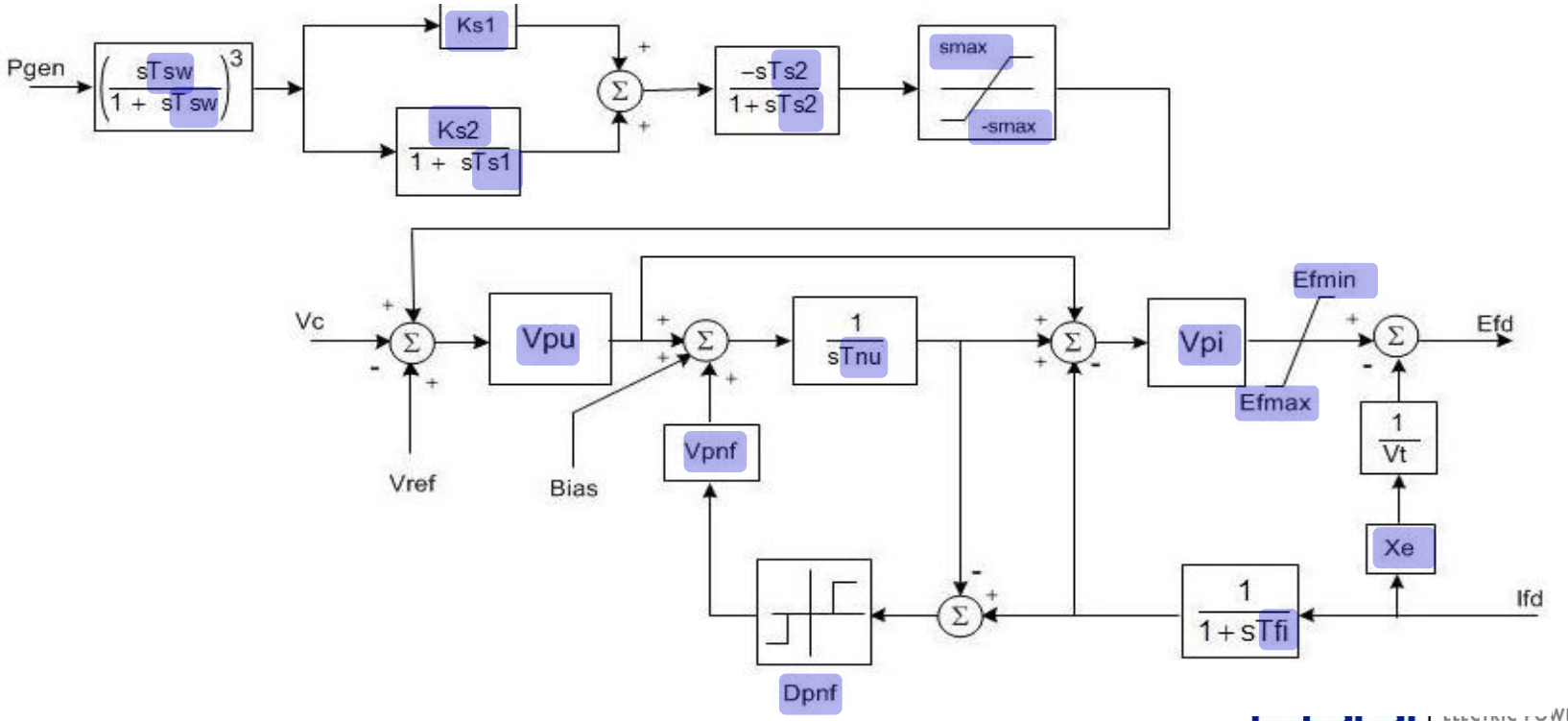
Name	*Description*
Efd	Generator field voltage
Ifd	Generator field current
Vc	Compensated generator terminal voltage

Initialization Outputs:

Name	*Description*
Vref	Voltage reference
Vs	Power system stabilizer (PSS) output – initialized to zero
Voel	Overexcitation limiter output – initialized to large negative value
Vuel	Underexcitation limiter output – initialized to large positive value

CIM for Dynamics

- Function blocks
  - Can be many, many standard models of a given function block type (60+ Excitation System standard models)
  - Behavior described by a diagram that has specific parameters to allow tailoring the behavior for a specific piece of equipment, like this diagram for Excitation System model ExcLIN1



CIM for Dynamics

- The problem with modeling Dynamics: how to cast interconnection patterns and function blocks into CIM UML
  - No precedent for describing functions or equations
  - No precedent for describing input/output flow connections
- Thankfully, for standard models:
  - Function block behavior is documented by named published standards (including initialization handling)
  - Standard interconnection usage is understood

CIM for Dynamics

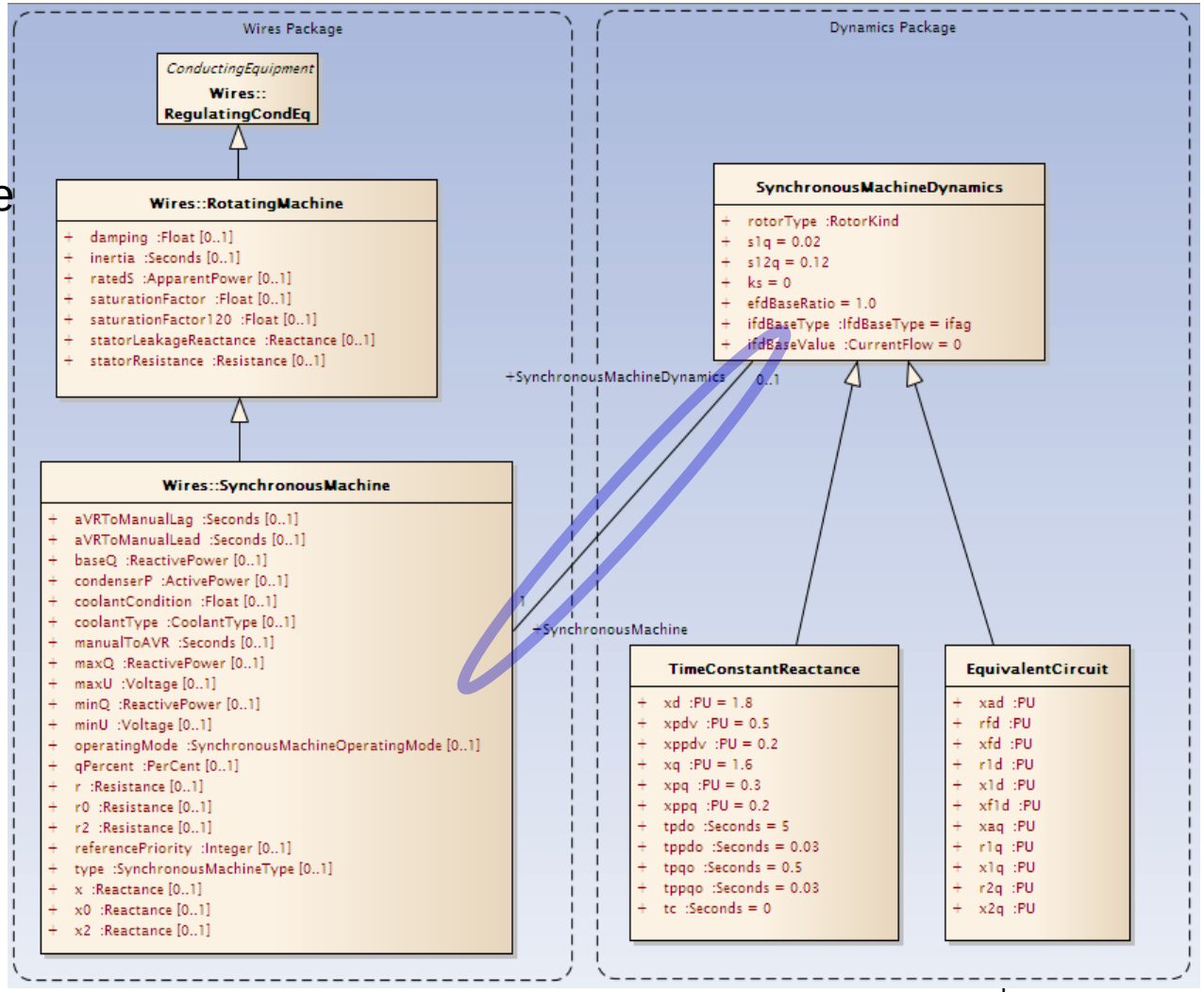
- So sufficient description of dynamic behavior requires only the following to be shared:
  - Where the generator, motor or load is connected to the network
  - Which standard models are participating
  - Parameter values for each standard model

CIM for Dynamics

- Where it's connected

A relationship to

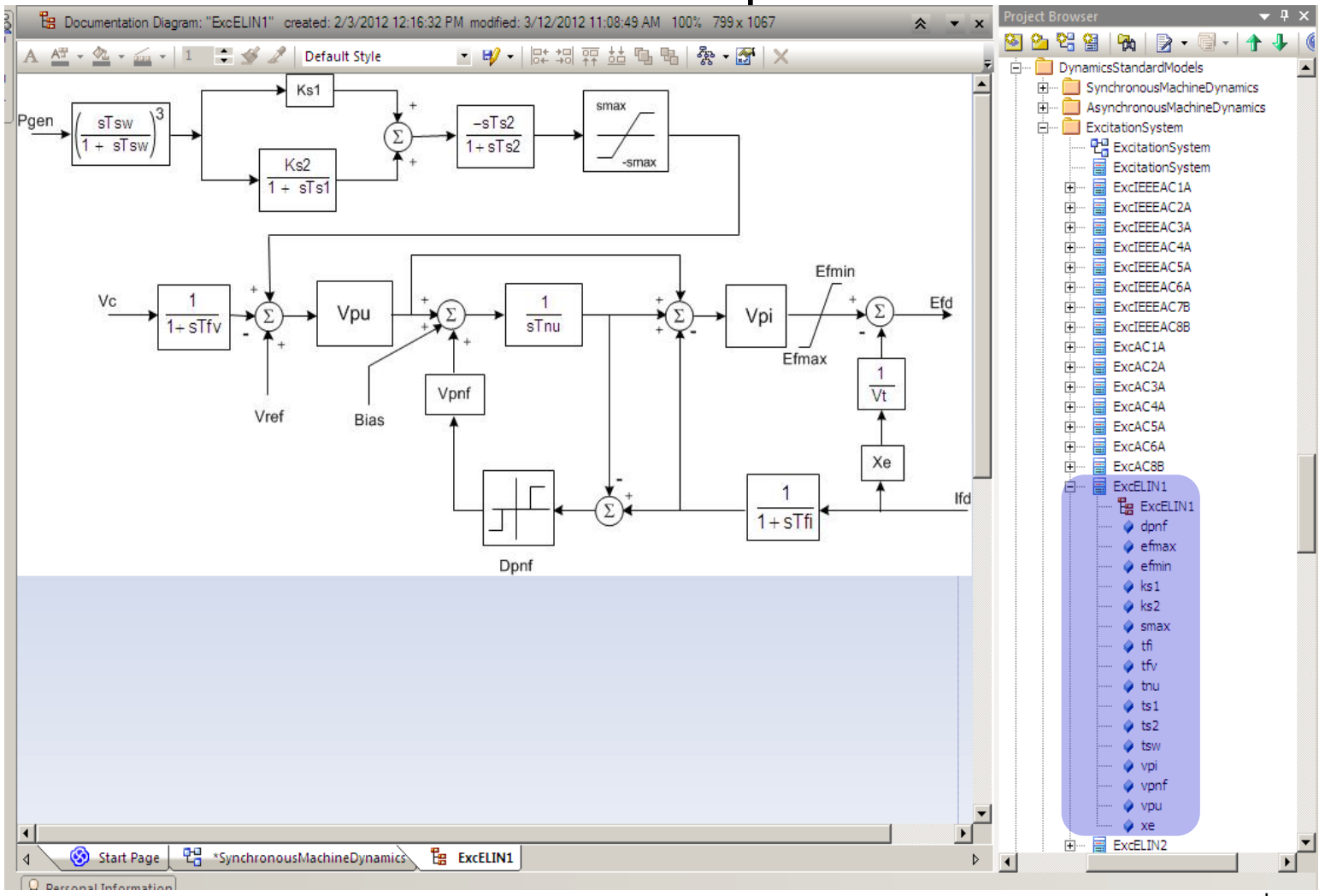
- SynchronousMachine
- AsynchronousMachine
- EnergyConsumer



EPRI ELECTRIC POWER RESEARCH INSTITUTE

CIM for Dynamics

- Which standard models and the parameter values



EPRI CIM for Dynamics

- History
  - Started in 2008, revived in 2011, given wings by ENTSO-E
- Lots of funders
  - Utilities: Oncor, Alberta Electric System Operator, British Columbia Transmission Corp., ConEd, FirstEnergy, ISO NE, UTCE, NYPA
  - Vendors: Areva T&D, DigSILENT, GE, Siemens PTI, Tractebel
- Current effort has wide participation
  - Leadership: Terry Saxton (Xtensible), Chavdar Ivanov (ENTSO-E), Pat Brown (EPRI), Chuck DuBose (Siemens)
  - Contributors: Christoph Schmid (Dig SILENT), Christian Merckx (Tractebel), Ferdinando Parma (CESI), Giatgen Cott (NEPLAN), Kendall Demaree (Alstom), Lars-Ola Osterlund (Ventyx/ABB), Kurt Hunter (Siemens), Tanja Kostic (Ventyx/ABB), Dario Frazzetta (ENTSO-E), Bill Price (independent)

CIM for Dynamics

- Status
  - 150+ standard models identified, documented and entered into UML
  - Preliminary inclusion of Wind models - collaboration with IEC TC88 WG27 who are developing dynamic models
  - UML-driven documentation strategy utilized
  - **NWIP and CD under consideration by WG13**
  - **Hopefully in CIM16**
  - **Use planned by ENTSO-E and ERCOT**

CIM for Dynamics

- Questions?

- For more information, contact
  - Terry Saxton tsaxton@xtensible.net
  - Pat Brown pbrown@epri.com
  - Chuck DuBose charles.dubose@siemens.com
  - Chavdar Ivanov chavdar.ivanov@entsoe.eu

Together…Shaping the Future of Electricity