Rethinking Simulation Tools with GFM

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GFM Inverters and a Look to the Future

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Looking for gaps

Please note that this presentation is an intro/overview of the fully interactive Tools document on the G-PST website.
The link is provided on Slide 11 of this presentation. Thanks!

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Learn more about the global Power System Transformation Consortium here: https://globalpst.org/

Summary what we're hearing from the Founding System Operators (of G-PST)

A view from the top: Pressing Concerns

- Are present tools giving answers that can be trusted? Are they valid, compared to the real world?
- Are present (simulation) tools being used properly?
- Are the current processes adequate for the future? Can we help the processes evolve faster?
- How can the inputs to the simulation tools be improved?
- How can the tools & results of simulation work be better used?
- How can the tools be used & modified to allow better decision making in this increasingly uncertain and stochastic future?
- How do off-line tools evolve into the on-line world?
- Are new tools needed to help leadership decisions, especially related to timing?
- How can they help with learning curves & human development?

Overview: Establishing a common baseline and identifying gaps in the Tools arsenal

Classes of Study Activities

- Planning
- Operations planning
- Operations guidance
- Interconnection studies:
  - Equipment design
  - Facility design
- Financial, economic
- Environmental

Tools for these types of studies are where the differences between IBRs and synchronous resource behaviors are most important

We attempt to present a view of the simulation environment presentlyused, and to identify where there are unmet needs for new or improved tools, as they relate to increased and new inverter-based resources

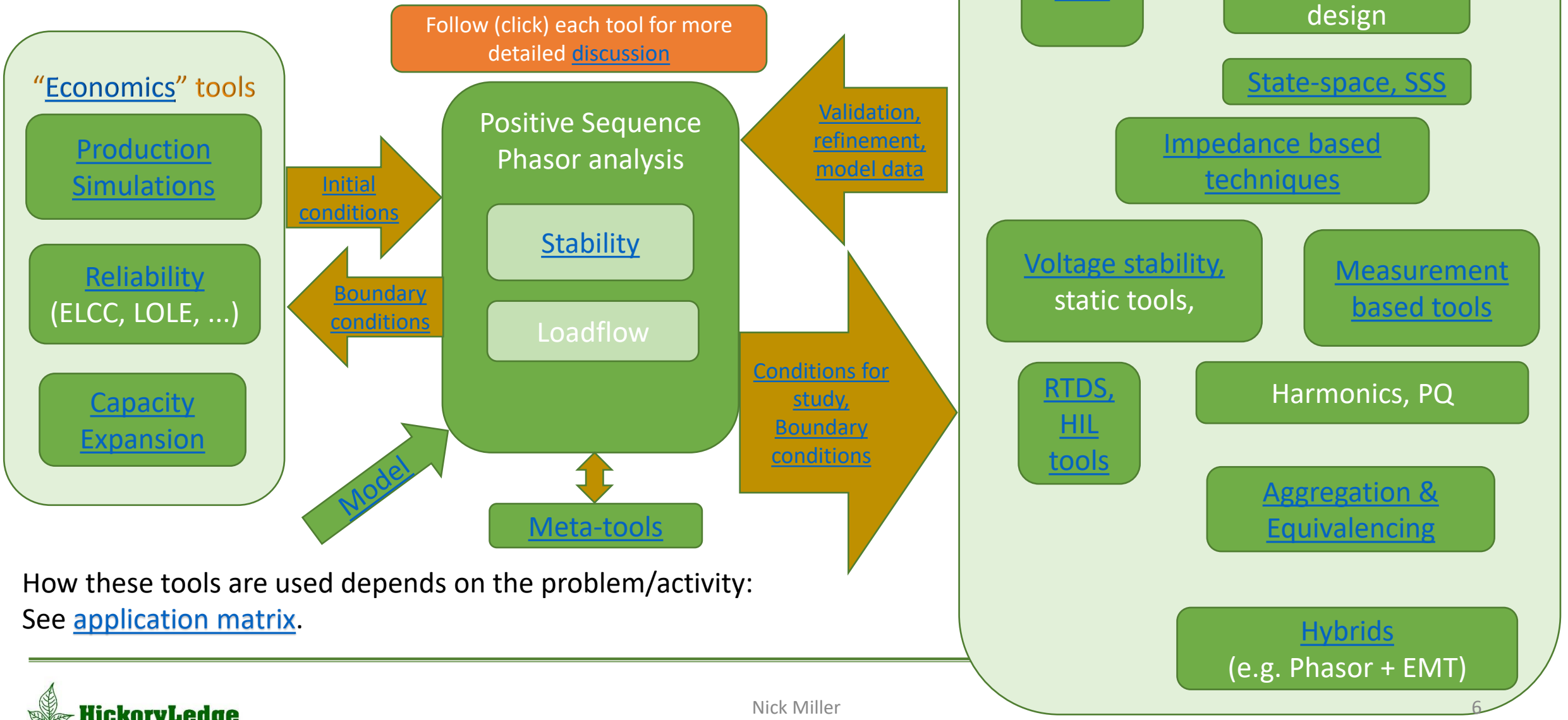
Stability Centric View:

- Phasor-based (positive sequence, fundamental frequency) time simulations, i.e., “stability” tools will continue to be the workhorse of the industry for a long time. The industry needs, with significant urgency, to:
  - Develop **better models** (and possibly other improvements to solution algorithms, data handling, etc.) for available equipment.
  - Develop supporting **tools/linkages** between tools that advise and improve the use of the phasor-tools and the decisions that result from simulations.
  - Establish better understanding and guidelines for where the presently available tools/models are legitimate, **when they fail, where they can be trusted, and where not**.
  - Develop **1st generation GFM models**, with our present best guesses incorporated, with the full knowledge that they are imperfect. The journey followed by WECC/IEEE with the generic WTG models comes to mind.
  - Consider **long-term development** of tools that might replace, partially or completely, phasor-based stability tools; or interact with them in radically different ways.

“we need a tool(s) that can be run quickly so that one can examine many scenarios and conditions, but that is accurate when there is little synchronous generation online; a tool that has the ability of EMT for weak grid situations but that can be run like a full-scale stability program many times over.”

These links DON'T work here! The entire fully interactive Tools link is given on slide 11 of this deck!

Stability Centric Environment



How these tools are used depends on the problem/activity:
See application matrix.

Tools: Topical discussions

This section provides links to discussions that can guide tool development. IBR related gaps are noted where appropriate.

Follow links to explore the following topics (and return here).

- Meta-tools
  - Example meta-tool: Simulation confidence
  - Example meta-tool: What tool to use? tool selection assist
  - Example meta-tool: Contingency analysis
- Stages of tool development
- Attributes of good tools
- Who uses what tools?
- What's a model?
- Humans and tools
- Stochastics & Probability

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EMT: Electro-Magnetic Transient tools

Building a consensus on R&D gaps here

Language:

- AKA, (generically):
  - EMTP (used generically)
  - Point-on-wave
  - Three-phase transient model
- AKA (brand names):
  - EMTP (the original)
  - ATP
  - PSCAD
  - Simulink
  - Others..

Key Attributes:

- Detailed design and research workhorse
- Multiphase; detailed representation of physics;
- Primarily DEs, including network. Time frame ~0.1ms cycle to 1s of seconds
- Well suited to difficult specific equipment issues;
- Large systems difficult; very large systems extremely difficult
- High user skill requirements; High GIGO risks

Relationship to Stability:

- For validation of PSFF
- For design of controls; input to PSFF
- For dealing with multi-frequency (i.e. not just fundamental frequency) phenomena
- For analysis, including large scale, of Weak Grids
- Some systems trying to substitute EMT for PSFF at analytical center.

IBR gaps:

- Available IBR models often proprietary
- Generic IBR models of debatable utility
- SOA GFM models scarce
- Access to controls
- Ability to quickly, successfully run large systems...

further discussion started at this link

EMT

EMT GFM models

Linkage: Economic tools to Stability tools

Overview & Language:

- Stability simulations normally start from a single snapshot: i.e. a specific operating condition
- Production Simulations produce thousands (hourly or faster) of these snapshots, with real(istic) commitment, dispatch, loads, etc.
- Most *nodal* production simulation tools can, in theory, export loadflows

IBR gaps:

- Today, linkage is minimal. "planning cases" are set (e.g. summer peak, etc.). Accompanying commitment and dispatch usually loosely based on experience and production runs. Data sets often "align" poorly. (often owned by different parts of organizations).
- Tools to select "hours" that are most meaningful for stability analysis need improvement.
  - This is fertile ground for research; and links to other stability research
- Tools that make it easy and efficient to "export" cases to stability tools are needed.
  - This is a task for standards creation; standardized, non-proprietary data exchange formats are needed
  - Also, for the software vendors, as mechanics of data exchange can be poor.
- Tools that make it easy for the data sets (stability and production) to be compatible are needed.
  - This is an institutional challenge/task for owners of the databases.

Simple case export

Screening tools to select "best" hours for export to stability

Having this separate from the stability to economics tools hides the need for there to be iterative exchange between the two platform to get good results today.

Stages of Tool Development

Software tools are not useful to end users unless all stages of its life cycle are addressed.

Stage	What?	Who?	Comments
Specify	RFP; clear functional requirements; clear conceptual objectives	Funding entities, GPST, gov't, end users	Ownership; initiative; prioritization can all be challenges
Develop/Prove	Test concepts; write proof-of-concept codes/tools; exercise, demonstrate	Researchers, universities, and/or commercial software vendors	Researchers tend to do this well, if the idea has merit and the spec is well thought out.
Scale Commercialize	Implement in (or "next to") the commercial tools. Make it "work" with real IT systems, real data sets, with acceptable computer burden	Needs to be cooperative effort between researchers and commercial software entities. Today it's "somebody else's problem"	This is a step that researchers, software businesses & industry are failing on repeatedly. Needs viable business models.
Maintain Train Evolve	Keep it working; provide training; fix bugs; answer the phone; make upgrades; make it "talk" to other software tools.	Combination of commercial software companies and end-user organizations.	This is often a failure point. Insufficient funding, institutional memory, glamor, ownership

Moving Forward

- The tools environment is complex, and users have highly varied priorities: there's a lot of cooks in the kitchen
- Successful transformation requires that all the component tools
  - Evolve & Improve
  - Work together
- Details matter: Individual tools most do both.
- We all need to keep talking about what is really needed:

https://globalpst.org/wp-content/uploads/Tools-Team-Presentation.pdf

https://globalpst.org/what-we-do/system-operator-research-peer-learning/pillar-1-inverter-based-resources-research-team/

This is the entire fully interactive Tools document!

Look for the feedback form

Thanks

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