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Oral Discussions on Session: "Managing Uncertainty in Power Systems" – Part I

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Abstract

This paper contains the first part of the transcribed oral discussions of Session "Managing Uncertainty in Power Systems" of the 2013 IREP Symposium-Bulk Power System Dynamics and Control, held on Thursday afternoon, August 29, 2013. Papers [1]-[4] were presented followed by the presentation of the written discussion [5] and the responses included in [6], [7].

Discussion

Chair: Are there any questions?

Yannis Blanas (Independent Transmission System Operator of Greece): I have a remark for the last presentation [4]. I appreciated the approach. It was very good, but you have considered as hypothesis that there is limited data exchange between the TSOs. This is not true. It is a very important obligation of all the European TSOs to achieve the observability of the neighboring areas. It is a very straightforward obligation and the TSOs exchange a lot of real time data and actually succeed to have almost the full network of the neighboring TSOs. So you have to reconsider your approach and if you want I can give some contact persons in the Swissgrid to confirm this.

Maria Vrakopoulou (ETH): Basically this is not my work and I will give you the contacts...

Y. Blanas: I don't blame you. I want just to improve it.

M. Vrakopoulou: I'll give you the contacts later of the person that worked on that, but I am not sure, for example in the day-ahead scheduling problem, if the TSOs exchange enough data so as to achieve let's say the optimal operation of the total grid. Because I guess it is something difficult to do and requires cooperation of all of them to achieve …

Y. Blanas: I will just try very fast to say that on the day-ahead they exchange snapshots of all the networks, there is a server where they submit all these data, and then they integrate all the data and each TSO uses the data according to each own requirements in order to perform security analysis.

M. Vrakopoulou: Ok, but in the end does everybody agree with the security requirements that result? Does each TSO agree with the others?

Y. Blanas: Ok. I propose we discuss it later.

Anthony Papavasiliou (Catholic University of Louvain): I have three questions Efthymios Karangelos [3], but they are going to be quick.

Efthymios Karangelos (University of Liege): You are supposed to be my friend. Three questions?

A. Papavasiliou: I am your friend and I really liked your work. So here are the questions. The first question is: I am not sure how you capture probabilistic constraints in a Mixed Integer Linear Programming formulation. The second question is: you mentioned it is a 3-stage model. I think the first stage of uncertainty is failure of components. I think, if I understood correctly, the second stage of uncertainty is whether the action was successful or not, and I am a bit curious if you can elaborate on how you capture that in the model. And the third question is: is this practical for large-scale systems and how long did it take for you to include it in the system that you showed to us?

E. Karangelos: Ok, can I do it in reverse order, because I think it is easier to respond to that? Ok, if it is practical for large scale systems: we have done the two area RTS, we haven't done real life practical system and to be honest there are different limitations before this is done in real life, such as finding all the correct coefficients for severity functions and so on. It's quite a heavy formulation. I don't have the times to quote at this stage, but it is definitely interesting to reduce it. There are some thoughts on that. Going back to the second question, about the stages of uncertainty, you were quite right. The way that we capture them… I think you were interested about how we capture what may happen in the second stage between the different possibilities about the behavior of corrective control, given the fact that we model only the two cases that I showed, one that everything happens as planned, and the other that nothing actually happens as planned. There is a very straightforward manner to do this, because essentially we do have to repeat all the corrective stage constraints twice. But in the repetition, of course, in the failing mode, all decisions are frozen. And going back to the first question on how we can do probabilistic constraint in a MILP, I think it would be much easier if I showed to you in pen and paper, but again it involves binary variables.

Papavasiliou: Do you use sampling?

E. Karangelos: No, we don't do the sampling because unfortunately we have a non-convex problem because of binary…

A. Papavasiliou: Maybe we discuss this later.

E. Karangelos: Yes, thank you.

George Gross (University of Illinois): My question is to all the presenters because each of you has gone into the probabilistic area. And I know we live in a big data environment but how are we going to get reliable probability data? Don't all of you start at the same time, ok?

Camille Hamon (KTH): Are you talking about outage rates for contingencies, or probabilistic forecast of the wind power, for example?

G. Gross: Everybody has expectations and everybody has probabilities. And I have never been able to find any kind of reliable data to complete the probabilistic framework. Nobody seems to have that data. How are we going to get some reliable data so that when we do probabilistic analysis? Clearly this is much better decision making because we take into account those occurrences that may not have 100% probability of occurring. So I am asking for some ideas of how you think we can get these data.

C. Hamon: I think that's a good question, because we can have a central based system where the system operator makes the forecast and distributes the forecast to the operators. That's one possibility, or otherwise each operator can make its own forecast, but then the system operator does not have access to this forecast, so I think that's the issue here. From the system point of view I guess it is better if everybody uses the same forecast distributed by the system operator.

M. Vrakopoulou: I also agree with you that it is very difficult to achieve reliable data for that reason, but I believe it is good to move from the deterministic formulations that we have to something less…

G. Gross: We are not arguing about that…

M. Vrakopoulou: Even if the data are not that reliable, even if they contain some errors, it might be better for the system instead of the deterministic approach.

E. Karangelos: I honestly thank you for your question, but… I have an answer as well. I think you have a very valid point in the sense that the data are not there to get, but I don't think our job is data collection. I think our job is to make the point that this data can be very useful and drive the need for the data to be collected. We are not in that business, we are in the business of proving what is the best to be done, which data should be collected, which data perhaps may be relevant. So I think we are doing our part in the quest for that as well. …

G. Gross: I don't want to disagree that you are in that business, but let me just tell you that when I developed optimum power flow in my company, it took a year and a half to get a guy full-time just to put together the first data sets. Be aware that just because we have the tools, this doesn't mean that people move into it. That's the reality. The second thing in terms of the issue about operators sharing everything, I just want to say that probably, in the US at least, we have more a "don't ask, don't tell" policy and, so consequently, not very much gets shared.

Claudio Canizares (University of Waterloo): This is a comment and a question for the second paper [2]. Back in early 2011, we presented a paper in which we discussed the security constraints for OPF using neural networks for describing the feasibility boundary [8]. You used a different approach. Professor Annakkage from the University of Manitoba used a similar approach using polynomial functions [9], but in this paper basically you don't concentrate on the stability boundary but on the security boundary, which means that you account for the fact that we have N-1 security constraints. So in other words the boundary shrinks a bit. But we found that in this approach there were two problems. The first problem was that because you try different directions, while you are trying to represent a surface basically, in each different direction the contingency might be different so you end up with very difficult boundaries let's say, not very smooth. So that was the first problem. The second problem we found was that when you have this approach, you have to represent the main interfaces in the system. For example in the Ontario system these are about 20-25. So you are dealing with a 20-25 multi-dimensional surface, which is not easy to find. So that has some difficulties when you solve your problem. So I would like to sense… to have an idea if you looked at that problem, first, and second, if you looked at that problem, how do you reflect it in the approach you are presenting here for representing the security boundary. Thanks.

C. Hamon: Thank you for the question. First, we develop second order approximations for each post-contingency case. We have a set of approximations, each approximation for one smooth part of the boundary, and we have such sets for each one of the post-contingency cases. And then for the multi-dimensionality issues, we actually tried in a bigger system than this to compute the secondary approximations that was, I think, with 20 loads and 10 generators, and we could compute second order approximations of the stability boundaries. But I think that is an important point, the issue that you raise, because this is the time consuming part of this method. It is because of this multi-dimensionality aspect of the problem, we have to search in many directions to find the stability boundary and this can really take some time when you get up in many dimensions.

Ian Dobson (Iowa State University): I suggest for the data collection issue that we need to directly mention the money. We need to put a value on the data. The purpose of our work is to say that you can save so many euros, or so many dollars, if you collect the data. And that's where we should try to get the discussion started: to put a value on the data, to incentivize people to collect it. I mean it is a huge problem and I would suggest mentioning the money up front.

E. Karangelos: I think it is a very valid point, because it may be the case that the money we need to spend to collect the data is much more than the money we would save with it. So let's be aware of that. I wouldn't proceed…

Omid Alizadeh Mousavi (EPFL, Switzerland): I have a question for all of the authors. It's about the optimization of system with uncertainties with reference to the definitions of robustness and resilience in the paper of Prof. Lamine Mili [10]. For robustness we have the usual kind of perturbation, but for resilience we have unexpected extreme events. And as far as I know we don't consider these extreme events for the management of the resources and I wanted to know how you evaluate your optimization solutions with respect to these unexpected extreme events, which may have kind of dependent outages, or cascading outages?

Quentin Gemine (University of Liege): I don't think the issue is related to my paper because it was not about contingencies and stuff like that.

C. Hamon: In our paper, we take some contingencies to analyze, but any other contingencies that might happen we do not consider them so far.

E. Karangelos: Actually, one of the things we want to do, as soon as we are able to do realistic case studies in the framework that we have, is to be able to identify whether or not some of the very low probability events should be treated as possible threats and whether or not they should be neglected. So far there is no starting point different from what is the societal cost, what is the impact to the end users of covering or not covering a certain event, and then we just select on the basis of that. And of course there is a second issue in the selection process, which is what we should consider realistically probable: what probability value is to be considered realistic or not. But the basis for the decision is only that after all. It is what matters to the users and not whether it is high or low in terms of the probability of happening.

O. Alizadeh Mousavi: But at least if you don't consider this kind of contingencies in the optimization, you can evaluate your obtained solutions to see how these different optimizations behave in response to the extreme events like cascading outages. I mean the Monte Carlo simulation you are using for the evaluation of your optimization solutions could consider time for cascading outage to see how the optimization solutions respond.

E. Karangelos: I agree with your point. There is nothing further for me. I don't know if somebody else wants to respond…

Pete Sauer (University of Illinois): I don't remember who it was that brought up the Edgeworth series [2], but can you tell me (that's sort of the same as a Gram-Charlier series), did you do it for scalars only, or did you do that for multi-dimensional distributions? If you did the multi-dimensional, how big?

C. Hamon: We used scalar and two-dimensional Edgeworth expansions.

Naoto Yorino (Hiroshima University): I just have one question about security management. I think that security management is a kind of risk management. Risk management means that if the very big risk happens, everything will be ok. Thus we have to avoid that very severe risk and in this case I think many of you use the expected damage, which is the occurrence probability multiplied by the damage. In that case, even if the probability of occurrence is very small and the damage is very big, so the multiplication is compared to the barrier… Maybe we have some barrier, but is it meaningful or not? So that's my question.

E. Karangelos: Was it to all of us or for someone specific?

N. Yorino: For everyone.

E. Karangelos: I think I can go first because it is probably the easiest in my case [3]. Probably I have not made myself clear enough in the presentation, but it's not the case, we do not decide for events like that, on the basis of the expected value. We control events that are let's say sufficiently probable, under the condition that they are all sufficiently severe. So there is discrimination between those factors. We do not aggregate all the expected values. Of course we use the expected values to make the trade-off between minimizing costs and consequences, but we do have a hard explicit constraint on catching events such as the ones you described.

C. Hamon: In our case the probability for outage rate is very small, but also the probability of the system to become unstable is very small as well. So we will be estimating very small probabilities there.

M. Vrakopoulou: So for us this goes quite close to the risk constrained OPF that we presented. We account for the probability of the outage and some function that corresponds to the severity of this outage. And this, inside this probabilistic framework, causes us to be sure then that this will be satisfied in the end.

Rachid Cherkaoui (Swiss Federal Institute of Technology, Lausanne): A very simple question to Maria Vrakopoulou [4] concerning the multi-area optimization. Are you using centralized or decentralized approach?

M. Vrakopoulou: The approach that was shown, for example, to deal with limited topology knowledge is a decentralized approach. So it is the distributed algorithm that I briefly showed in the end that it is basically an iteration that tries to find an agreement between the different TSOs on the cross-border power flows and prices. Is that answering your question?

R. Cherkaoui: OK. Thank you.

Chair: Let us thank the presenters and adjourn for 15 min coffee break.

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