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Comments to the FERC Docket No. RT01 -- 01 regarding Formation of the RTOs

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Executive Summary

In this filing Dr. Marija D. Ilić and Mr. Y. T. (Philip) Yoon, of M.I.T. in Cambridge, MA jointly bring forth a comprehensive proposal which they consider to be essential for the progress as the electric power industry continues to change. Dr. Ilić has been one of the most active researchers in the field worldwide, and Mr. Yoon has been working under her guidance for more than five years, as a Ph.D. candidate at MIT, in the Department of Electrical Engineering and Computer Science. Jointly, they have made numerous presentations to the community on the subject of transmission provision and reliability under open access [2], [3], [6], , most recently regarding the formation of Regional Transmission Organization (RTO) in New England (NE) [7]. Mr. Yoon will complete his doctoral degree at M.I.T. by the end of January 2001 and will assume a postdoctoral position at the M.I.T. Energy Laboratory following the degree completion for the next two years. His postdoctoral research studies involve working full time toward a further development of the ideas presented in his doctoral thesis [14] concerning the formation of Independent transmission company (ITC) and the development of long term transmission markets.

This filing provides a summary description of the overall vision for forming an RTO, with many technical details provided in the attached documents. The summary is attempted to give a big picture as well as many details of the necessary ingredients for forming a successful RTO; it further suggests the role of the proposed RTO design in light of the overall performance and the effect of the proposed designs on the individual entities. As it is well recognized, deregulation has brought about strong incentives (good and bad) to individual unbundled entities with their own business objectives. The ultimate challenge is to have all the pieces work toward the social welfare improvements over the longer periods of time under various uncertainties, when the individual businesses operate to meet their own objectives. It is in putting these pieces together, and understanding their interplay, that market design rules and right regulation play fundamental role, which gives incentives for offering value to others at the carefully designed tariffs. It is our strong belief that, because of the overall *complexity* of the regulatory, economic and engineering interplay never before experienced in any other industry restructuring, this big picture must be kept in mind as particular proposals for RTOs are being evaluated.

SOME CRITICAL OBSERVATIONS

It is impossible to proceed with proposing designs for effective RTOs and/or their evaluation and comparison, unless several major features unique to the electricity markets are kept in mind. Most of these are unique to electricity. Prior to describing our proposal for a possible RTO design, we list and briefly describe the relevance of our observations of these features in relation to the subject of this filing.

Observation 1: Non-storability and its implication on the need for forward markets for energy

To the best of our knowledge, the argument involving non-storability of electricity has been used primarily to support the need for short-term balancing (spot) markets when providing electricity competitively. It has become clear only very recently that a much more dominant effect of non-storability is on the long-term shortages of capacity (the case of recent California power shortages - it is very difficult, close to impossible, to respond by building more capacity based on short-term spot electricity price signals). Industries with sizeable inventories (including Federal reserve for gas and oil) are capable of filling the shortage from inventories while the new capacity is sought after, and, moreover, the value of storage is exactly dependent on a typical delay in developing new investment and additional capacity. Price elasticity on the demand side is a temporary solution to shortage, particularly in a society used to a high quality, relatively inexpensive, electricity service. We have suggested in the related work in our group [9] - [13] that systematic regulatory rules which encourage liquidity in long-term forward markets for energy are essential for long-term adequacy of energy supply, and, consequently, on long-term price stability.[1]

Observation 2: Non-storability and its implication on the need for forward markets for transmission

At this point one must recognize that it is practically impossible to have a liquid forward market for energy without well-thought through delivery (transmission) provision. Again, the argument is two-fold and is directly related to the non-storability feature. First, short-term physical delivery will be impossible and/or very inefficient without the right delivery infrastructure. Second, the forward markets for energy are very sensitive to the existence of meaningful long-term markets for delivery. A void in systemic delivery infrastructure is sure to impinge on long-term market liquidity in energy markets (including local market power effects). Moreover, without long-term mechanisms for valuing delivery service, there will be no investments in reinforcing the existing grid; the transmission and/or distribution businesses are likely to have existential problems. The main objective for creating an RTO should be to have designs which have long-term positive impact on energy markets and create a basis for sustainable wire business at the same time.[2]

Once this basic objective of the RTO is understood, one could proceed to recognize further complexities unique to the delivery process. It has been some time since we wrote an article pointing out/predicting fundamental problems with open access transmission without well-defined regulatory setup [4]. At that time, this thinking was viewed as unnecessary detail and *not* critical. We suggest that this article be re-visited, as it points out to many problems now outlined by Federal Energy Regulatory Commission (FERC) in rationalizing the need for RTOs! This set of complexities concerns locational aspects of power delivery and its relative geography to the existing ownership and energy market boundaries.

[1] These include state regulation in support of forming load aggregators for small residential customers, in addition to the Federal regulation concerning competitive suppliers.

[2] Note: The only distinction made in this filing between transmission and distribution deals with the regulatory jurisdictions, Federal being in charge of transmission and states in charge of distribution. Given that the emphasis in here is on Federal regulation, we refer to transmission only. Nevertheless, much said here is applicable to the distribution function as well.

Observation 3: State and Federal Jurisdiction over Transmission under Open Access

As the role of control areas begins to diminish under the open access requirement, it is clear that it is not feasible to have a "win-win" situation for the existing and the new businesses. There is a tremendous issue brewing with regard to the state and federal jurisdictions under open access power delivery. It is our strong belief that the RTO design should proceed by leaving enough autonomy to the regions for their market designs. The Federal role is in sorting out the regulatory rules and market mechanisms for coordinating inter-regional transactions only. This goes back to the set of issues described several years ago in [4]. This open problem of "seams", as it has most recently resurfaced, is a serious one and should be dealt with at the Federal level, in close collaboration with the regions/states/control areas. There are many regions which are extremely dependent on the imports/exports. Not having a market mechanism for providing supply and demand curves for inter-regional transfers via tie-lines is a very serious flaw. In [5] we have provided a possible minimal coordination approach to this problem; this is the first solution of its kind in which the imports/exports are viewed as commodities with their own supply and demand functions. Any large portion of the US electric power grid which intends to be self-sufficient in terms of the overall supply and demand without much reliance on imports/exports even under contingency conditions is a natural candidate for an inter-regional transmission organization (IRTO) as referred to in [7], [1], [5] and [18].

The current industry restructuring process, unfortunately, seems to miss this fact and, consequently, much effort and time is being wasted on developing market design and tariffs which would lead to the win-win type solutions. This situation has been particularly harmful as transmission providers and regulators have been attempting to agree on transmission provision and pricing (tariff) mechanisms. There has been very little effort toward thinking of providing delivery services to the energy market participants at the value. Instead, the overall thinking has been focused on cost minimizing under guaranteed rate of return on capital investments. This is generally viewed as a "safe" no risk approach by the transmission providers. Unfortunately, the same providers are not realizing that regulatory requirements which require the transmission providers to ensure (at least) short-term reliability is full of risks and very dependent on the contractual conditions under which transmission capacity is provided to the system users. Possibly the most infamous example of this hidden risks is in adopting the Firm Transmission Rights (FTRs) sold by the ISOs on behalf of the transmission owners. We have pointed out in our recent presentation to the NPCC [6] that in a combination of short-term congestion pricing using nodal pricing together with the FTRs the only risk-neutral contract participant is the holder of the FTR; any short-term reliability related risks are borne by a transmission provider serving the customers. Specifically, whenever the committed FTRs are not simultaneously feasible, the actual congestion costs will be higher than made available from charges paid by the holders of the FTRs. Since the FTRs are intended to make the holders financially indifferent, they must be paid the congestion costs incurred. This charge is seen *ex post* by the customers or the transmission owner. Either way, a transmission provider is vulnerable because the delivery charges are increased and a transmission may lose customers, who may chose alternate, less expensive delivery routes.

This particular possible mechanism for transmission provision is used here as an example to illustrate a very critical regulatory role in approving one market solution over the other because 1) it is widely considered, 2) it shows fundamental lack of understanding of the relation between the (short-term) reliability risks and the unbundling of reliability responsibilities to different entities 3) it is not easily extended to the multi-market environment, unless identical solutions are forced on each region 4) it is one example of typical issues which arise when proposing transmission provision while observing the reliability criteria developed under the old regulatory paradigms, and their mutual interplay [2], [8].

Observation 4: Role of Reliability Standards

In her response to the Department of Energy [2], Dr. Marija Ilić recently recommended that a very basic look be taken into the underlying paradigms of reliability as the industry restructures. This should be done urgently and prior to proceeding with any rule-making and/or legislation regarding reliability of the US Interconnected Grid. Once the first assessment is done, a carefully designed R&D agenda for understanding the interplay of regulatory, economic and engineering innovations should be established, possibly at the inter-agency level of several government agencies. The questions raised by the Secretary of Energy regarding rule-making on reliability standards can no longer be answered in a meaningful way without this major effort.

The industry is undergoing a fundamental change in operating the system as affected by the newly evolving technologies and/or the regulatory changes. Currently, there is a tremendous misfit between what the operating and planning practices are and what might be possible under these changes. The deregulation has brought strong incentives (good or bad) to the old and new business entities. However, only a careful interplay of (partial) regulation, economic incentives (pricing of products and services) and the engineering/technical innovations could lead to the overall gain (social welfare over prolonged periods of time), while leaving enough room for decentralized decision-making by various entities.

Possibly, the hardest connection to make concerns the relations between the market specifications (contracts for products and services in the new industry) and the traditional industry standards (operating and planning) developed under qualitatively different regulatory rules.

The most relevant change of paradigm has to do with how various uncertainties are presented when one operates and plans the system being managed [3]. It is quite striking to recognize that reliability-related risk management must go hand in hand with the contractual specifications for products/services in the new industry. Understanding this concept leads to the notion of *reliability unbundling.*[3] The implications of this unbundling on business and quality of electricity service as seen by the customers are considerable.

One could identify at least three qualitatively different sources of uncertainty as the industry is changing: (A) Regulatory uncertainties, (B) Market designs, and (C) Equipment status/functionality

Traditional reliability standards, the ones which DoE wishes to enforce into law, *concern only (C) for the assumed (old) (A) and (B)*! At this point that it should become clear that we would be going in circles for a very long time unless a very serious look into the basic paradigms of unbundled reliability under competition are established.

Here are a few key suggestions to support the fundamental problem in hand:

- Suggestion 1: The (N-1) reliability standard must be replaced by a qualitatively different standard, see the attached [3].
- Suggestion 2: The reliability-related risks need to be shared by different entities instead of by utilities alone as often defined as the so-called *providers of the last resort.* Portion of

[3] The phrase is invented here for the analogy to more widely used functional unbundling.

electric service is likely to be provided through bilateral arrangements, in which adequate supply is ensured by the contractual agreements between the parties involved. The remaining users must be provided (as of now) by the providers of the last resort, which is the remnants of the old utilities. This puts a tremendous burden on the providers of the last resort, since according to this old framework, they are expected to manage all uncertainties created by the market/regulation, without adequate financial incentives (with less profit to be made on the supply side). This clearly implies unbundling of reliability contributions.

- Suggestion 3: The market design should accommodate these suggested changes. How the suggestions (1) and (2) are managed is very sensitive to the market design in place.

Based on this, it is fairly straightforward to understand that the short- term reliability requirement imposed on the RTO, for instance, cannot be met in an unconditional way unless reliability-related risks are well understood, and the right incentives are given to the parties to meet their share of reliability risks.

It is not an overstatement that the on-going crisis in California, in particular the financial status of the wire companies, are strongly impacted by the marketers not taking any (financial) responsibility for reliability-related risks. Instead, the utilities are assumed to have to do so unconditionally, and without any financial compensation. If this issue is not sorted out when proceeding with RTO formations, there will be no sustainable wire business in the future. (Typically, wires are used only up to 30% of their capacity under normal conditions. If there are no financial means of valuing the other 70% of wire capacity created exclusively for use under uncertain conditions through the longer-term contracts for transmission provision, the entire need for new investments in grid enhancements of various sorts will *disappear*!) For further detailed treatment of operating and planning paradigms under open access, and the notion of reliability unbundling, see [8].

OUR PROPOSAL FOR FORMATION OF A REGIONAL TRANSMISSION ORGANIZATION (RTO)

Our proposal for formation of an RTO takes the basic observations described above into consideration as the design is proposed. To start with, our proposal for forming an RTO differentiates between three qualitatively distinct cases: Case 1, in which all wires are owned by one single owner, for instance, a traditional distribution company serving a single energy market; Case 2, in which portions of the wires are owned by different owners, within a single energy market; Case 3 in which different transmission owners are facilitating transactions in a multi-market setup.

It turns out (after much soul searching), that what differentiates these three scenarios are types of (transmission) products and ownership of these products. We observe that it is *not* the size of a possible RTO, but this ownership of wires and the relation to the energy market(s) that ultimately determines how an RTO is designed and its performance is measured. In what follows, we define the transmission products, their ownership and, based on this, propose a possible design of the entire market (energy and transmission) necessary for providing systematic incentives to all parties.

Single Transmission Grid Ownership, Single Energy Market

This setup is the simplest one and is applicable to an island-type electric power grid, owned by a single transmission provider and electrically disconnected from the rest of the world (The National Grid in the UK is an example of this). The "product" being sold by the transmission owner to the system users is the total transmission capacity, for each line in the system separately. The problem is to establish a mechanism for investing into larger line capacity at the places where it is most valuable to the system users, operate the existing wires so that most is made out of the existing designs short-term and have meaningful financial mechanisms to give the right incentives for this to take place. Because there may be some confusion between the role of an RTO and the existing ISOs, we stress the basic role of an RTO for investments and longer-term delivery contract arrangements. The ISO, on its side, is concerned primarily with the short-term operations and possibly assisting the transmission owner for the planning.

The basic setup of the entire delivery design (RTO) is shown in Figure 1 [15]. The basic role of this entire entity (RTO) is to jointly accomplish the committed performance, and to nurture long-term investments necessary to provide transmission access through the forward market, which is further traded through the secondary market. It comprises the following entities:

- A) An Independent Transmission Company (ITC) selling its own product (transmission

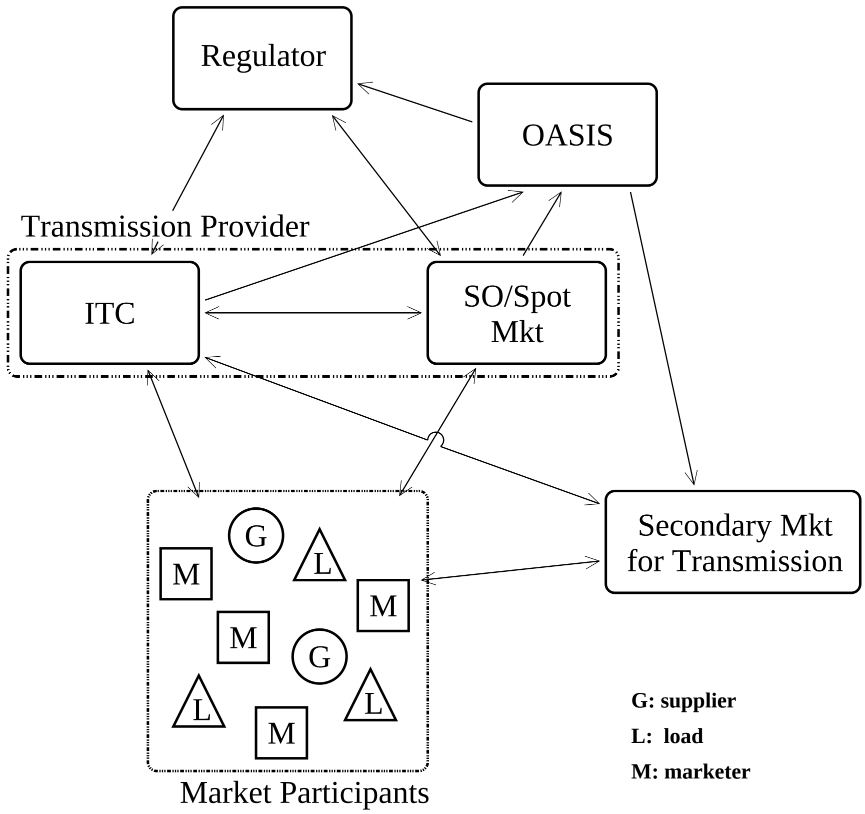

Fig. 1. Overall market composition under the newly proposed structure

line flow capacity). The income from these sales would be used to invest into enforcing a transmission grid.

- B) A pro-active (Independent) System Operator (SO) which cooperates with the Independent Transmission Company (ITC) to implement the contracts for delivery established between the ITC and the buyers of the product (line flow users). The physical implementation of the contracts established by the ITC is likely to be best carried out by the SO to further insure *independence*. The SO should also cooperate (or assist) with the ITC in determining how much line capacity is available for sale.
- C) An on-line information infrastructure providing well-defined specifications of the product availability, line by line. This information is continuously updated by a Transmission Provider (ITC/SO team).
- D) Secondary market for transmission in which multiple owners of each transmission product (portions of the total line capacity) meet under the well-define market rules to trade their products over time. They are generally trading the jointly owned products

purchased directly from the ITC.

.1 An ITC and markets for transmission

In [15] we describe a fundamental structure for the transmission provider (TP) composed of the independent transmission company (ITC) and the system operator (SO). Under the proposed structure, the ITC and the SO are two entities working cooperatively to carry out the functions of the TP. The entities are differentiated through the ownership and the operational authority. Roughly speaking, the ITC owns the regional network, provides various services connected with the longer term (physical and financial) energy trade, and carries out the related functions including making investment decisions. The SO, on the other hand, has the operational authority over the entire network, provides many services linked to the shorter term (physical) energy trade, and carries out the associated functions including managing transmission congestion.

At the minimum, there are three groups of entities and three infrastructures important for a proficient management of the electric power network. The three groups refer to the regulator, the TP composed of the ITC and the SO, and the market participants consisting of generators, loads and marketers. The three infrastructures are spot market for energy balancing, forward markets for transmission and the open access same-time information system (OASIS). This paper describes the role of TP with an emphasis on the ITC and the forward markets for transmission.

It is shown that the new structure is essential for fostering the operation and planning of the electric power network by the TP with a desirable level of efficiency and reliability while supporting the regional energy markets.

.2 Price Cap Regulation for Transmission: Objectives and Tariffs

In [16] we construct a mathematical metric for measuring the performance of the transmission provider (TP). The heart of the problem lies in developing the systemwide social welfare function which captures the unique role of the TP in the new industry environment where the electricity is provided through the market mechanism.

First, the benchmark performance measure is defined while accounting for the subtlety of functional unbundling in the electric power industry. This benchmark performance measure may be compared to the systemwide social welfare function for the omnipotent social planner, whose sole objective is maximizing the consumer utilities while minimizing various costs. The maximization of the benchmark performance yields the optimal level of the investment, the control effort and the maintenance effort into transmission. It is shown that under certain conditions, optimizing the benchmark performance leads to solving the optimization problem of the omnipotent social planner.

Following the formulation of the benchmark performance measure we describe two possible regulation schemes to be imposed on the TP, namely the rate-of-return regulation and the price-cap-regulation (PCR). The TP remains a monopoly through the restructuring process due to the assumption that there exists a high degree of the economies of scale and the economies of scope for the network. The main function of the TP is to provide adequate transmission capacity necessary for participants to trade electricity in the electric energy market.

Then, the systemwide social welfare function is developed under the rate-of-return regulation this time imposed on the TP. The restructuring of the electric power industry is still a relatively recent event at the time of this writing, and there is yet to be a consensus on the actual implementation scheme for regulating the TP based on the guaranteed rate-of-return. In this paper, four of the more common implementation schemes are described and examined using the corresponding systemwide social welfare functions.

It is shown that even though each scheme has a few distinct peculiarities that separate one from the others, they each suffer from shortcomings similar to the rate-of-return regulation imposed on the vertically integrated utility, most notably the burden put on the regulator in eliciting the social welfare optimizing behavior from the regulated firm, for the case considered in this paper, the TP.

The PCR is proposed as a possible alternative regulation scheme to be imposed on the TP. Starting from one of the regulation schemes described under the rate-of-return regulation we develop the systemwide social welfare function associated with the PCR and show that the main difference between these two regulation schemes is not on the functional form of the systemwide social welfare but is on the party responsible for solving the optimization problem.

.3 Secondary Market for Transmission and Supporting Infrastructures

In [17] we discuss two infrastructures important for proficient management of the network, namely the secondary markets for transmission rights and the open access same time information systems (OASIS).

Following the restructuring process the participants in the electric power industry are engaging in complex market activities to meet their electricity needs. Hence, the value of the energy and the transmission portion of electric services are determined by employing the market mechanism. These values once determined, are then communicated among the market participants through the prices specified on various contracts.

Many market participants enter into forward (delivery) contracts for energy. The forward price may be described as the spot market price for delivery of a commodity at a fixed time in the future. As a counterpart to the forward contract marketplace for energy, the secondary market for transmission provides the necessary mechanism for supporting the market activities so that the change in value is readily conveyed to all of the market participants of the forward contracts for transmission portion of electric services in the form of the intermediate term transmission contracts. Here the market participants may be the holders of the physical transmission rights, the holders of the financial transmission rights and/or the bidders in the spot market.

Without the presence of the secondary markets for transmission rights, the ITC relies solely on her expertise gained by observing the transmission charges imposed on the market participants in the spot market when determining the price to be charged for the transmission rights. This creates the open loop computation of the charge. However, with the presence of the secondary market for transmission rights, the ITC can observe the change in prices at the secondary markets for equivalent rights and take this into consideration in determining the price, i.e. in the feedback fashion.

With the introduction of the secondary markets for transmission rights we can compare the workings for the transmission rights in the form of the intermediate term transmission contracts proposed in this paper with the transmission congestion contracts (TCC) and the flowgate rights.

Multiple Transmission Owners, Single Energy Market

This is the case of New England, for well-defined rules on imports/exports. This scenario is qualitatively different from the single ownership Case 1, because of the inter-dependency of the transmission products (total line capacity) sold by the individual owners. This is an important distinction because the maximum flow that is available as a product to the system users actually depends on how much flows through all the other lines. Even more critical is the fact that it is effectively unknown how to decide on the maximum line capacity line by line without considering the entire system. This points into a real need for having a common (transmission) market place in which the seasonal and longer-term available capacity is estimated in a coordinated manner while allowing for sufficient autonomy to each transmission owner in terms of offering their supply functions for delivery (at the value) and the users providing the demand functions for deliveries across the ownership boundaries. In this case an RTO is such a meeting market place for intermediate (seasonal) and long-term (annual) selling of delivery services (by the individual transmission owners) and the purchases by the users of delivery services within the entire RTO area. The actual design of such a market place can be found in [5]. The RTO now facilitates seasonal delivery commitments, as well as longer-term through the forward markets for transmission described in [15]. This design is a particular case of a more general Case 3. The distinction is that in the most general case one could have multiple energy markets which makes it even more complicated, as described next.

Multiple Transmission Owners, Multiple Energy Markets: Inter-regional Transmission Organization (IRTO)

In [18], we describe the provision of transmission in the multiple regional setting. In each region it is assumed that a different market structure and diverse tariff system from the other regions may exist. For instance, this is the case of the interconnected network of New England, New York and PJM systems.

We, first describe the advantages and disadvantages of having the interconnections with neighboring control areas. Then, the newly proposed market mechanisms (and transmission provision) for implementing inter-regional transactions. The proposed mechanisms are then contrasted to the methods under the vertically integrated utility scheme and under the present restructuring process. Finally, the mechanisms are compared to the other methods recently proposed in the industry.

It is shown that the new structure is essential for fostering the operation and planning of the interconnected electric power network while ensuring reliability.

CONCLUDING REMARKS

Based on these observations concerning the overall complexity of the problem in hand, we respectfully suggest that the present practice of designing markets for electric power industry by attempting to do this through various committees and voting is not very satisfactory. It is fair to say that the results of restructuring process up to date clearly indicate this. The proposed designs for the RTOs should proceed with some understanding of the implications on the overall industry performance, as well as with understanding of the implications on the individual industry participants, such as power suppliers, provider of wires, and consumers. Particular emphasis should be on understanding the long-term (in contrast to only short-term) effects of various changes on the adequacy of supply and evolution of the grid necessary to support the long-term needs of the energy markets. The problem the electric power industry has in hand is much more troublesome and complex, in terms of the theoretical and practical challenges. It will take some deep thinking and patience to get it right. We recognize that our comments deal with a longer-term strategy rather than immediate decisions. Nevertheless, the sooner the community starts engaging into the fundamental thinking about the problem, the sooner one may see some real progress. Instead, one may go through several regulatory mistakes without fully understanding of the implication of different regulatory rule-making.

It is with our most sincere concerns for the industry's future that we have proceeded with offering these comments. As pointed out in [8], we are dealing with a much more difficult problem than it is broadly appreciated. R&D is merely trailing behind the problems as they present themselves. Many of these problems and decisions are likely to become more and more confusing unless serious effort is taken to have an open-minded look at the overall problems. Once again, university/government/industry collaboration may be very critical in making progress on this subject.

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