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Technology Innovation and the Rebirth of Self-Regulation: How the Internet of Things, Cloud Computing, Blockchain, and Artificial Intelligence Solve Big Problems Managing Environmental Regulation and Resources

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Self-regulation has never worked well. Technological advances such as cloud computing, blockchain, and artificial intelligence can improve the efficiency of regulation and self-regulation. Examples are drawn from environmental areas related to compliance enforcement, resource management, and greenhouse gas and climate change monitoring.

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It is possible to drive from Portland, Maine, to Richmond, Virginia, and pay all the tolls with one provider: E-ZPass (a private company). Why is it not possible to build similar simple overlay systems for regulatory compliance and resource management cooperation?

We face unprecedented challenges that require significant advancements in regulation and regulatory compliance to protect the environment and new tools to manage scarce common resources such as air, water, agricultural, and energy. We also need to better manage greenhouse gas emissions and facilitate investment in global warming mitigation. Regulators, industry, and public interest groups must find ways to work together to safeguard the planet.

The tools to upgrade both compliance enforcement and cooperation already exist. The Internet of Things and cloud computing are transforming the way we manage environmental challenges. Artificial intelligence (AI) tools and blockchain-like distributed databases are rapidly enhancing the value of smart, real-time cloud-computing solutions.

Going forward, regulatory cooperation and compliance can build on the E-ZPass approach. Overlay cloud computing applications open the possibility that key players can come together to develop and deploy transparent, real-time solutions to looming challenges.

21st-Century Challenges

Here are three major challenges that we struggle to address.

Challenge 1: Compliance Enforcement

When the few evade environmental requirements, regulatory rigidity increases and the many pay more. Further, the inconsistent and overlapping patchwork of local, national, and international regulations results in a porous barrier between pollutants and the local environment. To minimize the impact of pollutants on local environments, better tracking of enforcement and greater transparency is needed. For example, when there is an *E. coli* outbreak in produce, consumers often stop buying even unrelated food products due to a lack of reliable data. In contrast, air and water quality crises tend to be slower to provoke public response because they are less focused. Communities in every state are striving for cleaner environments, but on the national and international levels, progress is gridlocked.

Challenge 2: Resource Cooperation and Management

To prevent a tragedy of the commons, improved cooperative management of shared public and private resources is necessary. Watersheds and aquifers everywhere need better management. Water use needs to be adjusted during droughts, in response to climate change, and to offset the decline of "ancient water" in aquifers. Yet regulation is cumbersome, and measurement is inadequate. The management of lumber, grazing lands, and fishing rights and organic and fair-trade labeling face similar problems. Oil and gas fields often have good inventory tools but are not efficient in environmental compliance and transparency.

Challenge 3: Greenhouse Gas Monitoring and Global Warming Mitigation

One reason that action to mitigate climate change lags is a reliance on outdated tools to measure and inform decision making. For example, cap and trade and carbon taxes use inflexible legacy 1970s methods to contract and track flows. New investments yield cleaner environments, but not enough capital is flowing in because of limited coordination and little reliance on market pricing.

Environmental Management Requires Significant Reform

Compliance enforcement is undercut by regulatory cat-and-mouse games that impede progress, freeze negotiating positions, and confound efforts to produce more integration and interactivity.

Current regulatory methods, company reluctance, and the absence of a common tracking framework make it impossible for parties to clearly understand the situation so that they can enter into practical trade-offs. Data hording is counterproductive; data sharing built on mutual trust will allow easier

trade-offs. It may be possible to track results while promoting improvements through investment, incentives, and tax deductions. But, simultaneously, technological advances lead to more complexity and risk for business, political conundrums for policy makers, and information overload for consumers.

Policy disagreements are real. But business leaders hate uncertainty more than they hate regulation. Regulatory efforts to deliver a cleaner environment may constrain business, but they also protect industry from unexpected risks and liabilities. Still, the scale and speed of action need to increase.

Executives of leading energy producers have publicly endorsed the need to meet the Paris Climate Accord targets on emissions and global warming. Their global firms want regulatory relief but are equally concerned about the lax U.S. environmental regime, which forces them into two standards. The recent Environmental Protection Agency decision that loosens methane restrictions illustrates the industry split between global and regional players. Global players embrace major regional or global regulatory standards because the cost savings of a single implementation offsets many of the costs; the fervently antiregulation companies are mainly smaller players with smaller budgets and frequently questionable records. Their political activity is meant to help them get around rules that they cannot or do not want to meet.

But more than regulatory compliance is involved. In some sectors, little has changed since the 1800s. Conflicting, overlapping regulation is spread across public entities, nonprofit cooperatives, and private companies. Streamlined cooperative resource management, including subsidy management, is needed across the board.

Investment and incentives also are essential tools to steer action. Sometimes they can substitute for regulation. For example, although solar and wind investments are treated as a political football, they are effective and popular with both Democratic- and Republican-run businesses.

Can Industry Self-Regulate?

Technological innovation opens affordable pathways forward for industry that regulators can enforce. AI-based monitoring should produce more reliable enforcement checks on corporate behavior. Corporate self-regulation will need to be monitored by software and time-stamped, locked database records that are accessible to the public as well as to industry and regulators. For example, Boeing’s failure to catch major problems in its 737 MAX fleet does not mean that government should take over testing, but it does show that better oversight tools need to be available to regulators.

At least since the days of medieval guilds, every industry has negotiated from governments space for industry-managed and self-regulated initiatives. Self-regulation is common and takes various forms. For example, product standards are set by Underwriters Laboratories (UL), a private safety certification consortium. Similar industry groups work in arenas from network interoperability to plumbing pipe standards to promote product and environmental safety, reduce costs, and ensure interoperability. Procedural standards ensure that lawyers and other professionals follow common practices and certification. Insistence on best practices improves cooperation among industry associations, cooperatives, and local business. And,

court or regulatory solutions address problems where voluntary solutions prove elusive, as with pollution settlements and out-of-court settlements.

The ultimate responsibility for enforcement remains with governments; the challenge is to build flexible regimes that use regulation and incentives based on real-time field data.

The Digital Transformation Enables New Multi-stakeholder Solutions

As digitization proceeds, cloud-based applications powered by inputs from a plethora of sensors and phones deliver trust-but-verify solutions with different levels of transparency. These models allow real-time transactions and trade-offs to achieve common resource management and regulatory solutions.

Today, private cloud applications manage complex interactions among players (e.g., Uber, Lyft, and Airbnb) and transform how private resources are managed. The Internet of Things collects location data from Uber drivers' smartphones, manages the data in cloud-based databases, and uses AI to develop traffic and pricing solutions. Similar solutions are possible for regulation and shared private and public resources—without aligning institutions and policies.

A compliance system that is comparable to E-ZPass could track adherence to agreed-on regulatory requirements. A system for cooperation would produce better monitoring and management of shared resources. Both approaches enable overlay solutions that are easy to roll out; provide real-time monitoring, reporting, and trading; and give transparency instantly.

Solutions to Big Challenges

Returning to the three main challenges, what types of solutions will move us forward?

Solution to Challenge 1: Compliance Enforcement

To move environmental regulation toward a more cooperative, interactive regime requires less cheating and more compliance. New technological solutions make it easier to detect cheating and lower the incentives to cheat. Integrated cloud-based systems generate better data from Internet of Things sensors on, say, industrial discharges and use AI to compare results. The system compares these results to federal, state, and local regulatory requirements. The data are locked in an encrypted blockchain-like shared database from a third-party provider. The company controls the encryption keys and the same level and limits of access as now exist for current data release. Furthermore, the AI framework learns as it gains experience. It also can generate scenarios to steer public and private action that can reap quick rewards. Local players may take action more quickly when the local needs are concrete, compelling, and transparent.

For example, Kansas City, Missouri, recently launched a transformative smart city initiative to monitor and control existing city services and provide new ones, including air-quality monitoring and noise measurement. Micromeasurements can help direct city actions to check pollution in real time. And public pressure may be more effective than the current process in stimulating quick action.

Solution to Challenge 2: Resource Cooperation and Management

To optimize shared private or private/public resource management, cloud computing–based applications can monitor aquifer water levels (or forests or minerals on shared lands) from data from Internet of Things sensors. The data are held centrally by third-party providers or by each player in decentralized databases, and only pre-agreed-upon data are shared. AI takes the data and recommends how to maximize water and value within contractual and legal constraints. Scarce resources can be stretched, shared, and traded more efficiently. This, in turn, facilitates financing of new investments, incentives, and allocations for private and public projects.

Solution to Challenge 3: Greenhouse Gas Monitoring and Global Warming Mitigation

Cloud-based monitoring and marketplace applications for greenhouse gas emissions and global warming mitigation would bring regulators, industry, and community groups into a framework to make recommendations. Such solutions would encourage players to recruit new partners (e.g., farmers using sustainable farming practices or forest management companies) to reduce greenhouse gas emissions while also addressing subsidy challenges. Such projects could start on a voluntary basis and create real data before risky major policy steps are taken with little direct data.

In this spirit, energy companies already are investing in direct CO_2 abatement as profit centers and would accelerate their investments if appropriately incentivized. Real data from even a small percentage of participants are hugely valuable scientifically and politically.

Conclusion

To meet fast-growing environmental, regulatory, and resource management challenges requires developing robust, cloud-based frameworks of principles and norms. Rules and regulations also need to facilitate local, national, and cross-national applications solutions. Providers should also leverage technology to craft trusted and verifiable solutions where compliance is the norm.

Many issues related to implementation require trust in transparency and privacy, accurate measurement of results, and continuous experimentation. If shared governance models become the norm, this will foster greater cooperation among parties and stakeholders.

Technological advancements are overtaking major segments of the consumer and commercial markets. In today's digital economy, the principles of an integrated cooperative approach as exemplified by E-ZPass can provide a path forward in effective, affordable, and broadly adopted solutions. Tough challenges remain, but technology offers exciting capabilities to cooperate and provide new ways to improve the environment for the common good.