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PROGRAM ON TECHNOLOGY INNOVATION: TOWARD A UTILITY DIGITAL TRANSFORMATION MATURITY MODEL

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Abstract

As technology changes are rapidly transforming the electrical grid, these changes are making their way into the skills and competencies required of the operations personnel required to install and maintain them. These skill sets once were the sole domain of information technology (IT) staff. And these competencies permeate utility business units, often leading to pressure to better align organizational structures.

Prior research on the convergence of IT and operations technology has identified critical success factors, but the question remains; "How to measure those attributes that will lead to better collaboration between IT and operational staff?" This white paper describes an effort by EPRI and its utility collaborators to develop a "digital transformation maturity model" for electric utilities. The objective is to identify critical success factors that most succinctly are equated with an organization's maturity transformation and creating an action plan to do something about them. This first version has been refined through three workshops and provides a starting point; however, the development of a robust model requires that it be put into practice.

Away from "Convergence" – Towards Digital Transformation

Increasing numbers of sensors, more types of communications protocols, and added device capabilities have led to a greater need to transmit, store, organize, integrate, and transform data to achieve better operation of the electrical grid. This change requires operational personnel to learn new skills. This also requires that information technology personnel better understand the resiliency requirements of operations, which are different than those in the back-office. Until recently, groups of technology staff would provide support for these new demands, often replicating the organization and support capabilities of the core information technology (IT) departments. This leads to conversations about how to best manage organizational structures and staffing to support these new capabilities. But that also can lead to a culture clash within the utility among operations and IT staff using different languages to describe their respective needs, and with different expectations about required support levels. These changes led to efforts to better understand IT/operational technology (OT) convergence issues.

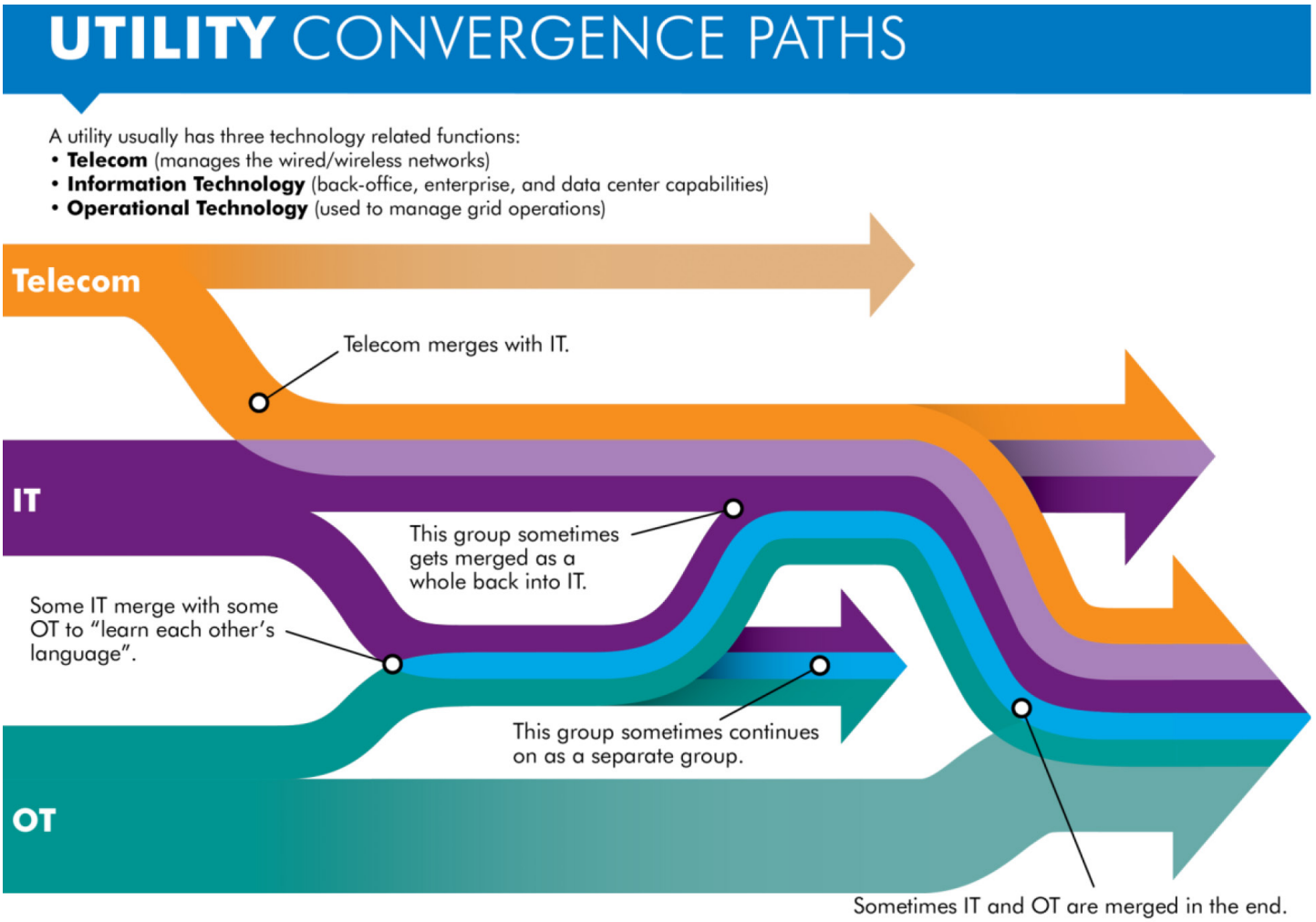

Figure 1 – Convergence "paths" often seen because of organizational realignment

Prior EPRI research has explored critical success factors of IT/OT convergence changes at utilities, attempting to better understand successful convergence strategies [1]. This research found there usually are one of three alignment outcomes whenever an organizational change occurred due to these technical pressures, shown in Figure 1.

1. ***Outcome 1:*** Telecom merges with IT, and with some support for OT, in the end the IT team reconvenes once changes subside.
2. ***Outcome 2:*** Telecom merges with IT, part of OT and IT teams converge and remain a separate group from IT or OT.
3. ***Outcome 3:*** Full eventual merge of IT and OT, including telecom.

Additional research explored other facets such as, taking an application portfolio approach to convergence [2], and exploring a cost-benefit framework [3]. This R&D culminated in the first EPRI guidebook on the topic [4]. The importance of language was highlighted when even the name "IT/OT Convergence" was met with resistance, aptly reflected in this comment by Ron Schmitz, Director of Information Services at Great River Energy: "As soon as you use a '/' you divide us." This in turn led to conversations at an EPRI advisory meeting, about naming that could reinforce the idea that "we're all in this together" – thus the notion of "digital transformation" was agreed upon. This reflects the idea that everyone in the utility should be "pulling in the same direction" as the electrical grid is transformed.

The next stage of development again occurred at an EPRI advisory meeting. Dawn Jurgensmeier, Manager of Information Technology Services Distribution Operations Center (ITSDOC) at the Salt River Project, gave a presentation on IT and operations convergence and highlighted three use cases where there had been opportunities for better communications between IT and OT personnel that could have avoided challenges with technology deployments or operation in the field. She then posited, "Could a[n] IT/OT Convergence maturity model be developed, that would highlight the traits and capabilities that would reflect a well-aligned utility?".

Keeping in mind the prior dissatisfaction with "IT/OT", the name chosen for this maturity model reflects "digital transformation," hence the Digital Transformation Maturity Model, or "DXMM." EPRI brings significant expertise to the table in the development and use of maturity models, having provided workshops for the Smart Grid Maturity Model as well as developing the Electric Power Sustainability Maturity Model [5].

Maturity models have long been used to measure, benchmark, align activities, and act as a starting point for transformation roadmaps. The original capability maturity model was developed in the 1980s [6] in response to what was often seen as project failures in the computer science domain that often-reflected inaccurate budgets, and projects that did not deliver on anticipated results.

Digital Transformation Domains

Measuring maturity often is a qualitative exercise. It can be difficult to find purely quantitative measures that can indicate the maturity of organizations' digital transformation capabilities. This also reflects the difficulties in dealing with the organizational trio of people, process, and technology which must be coordinated to successfully implement any transformation. Rather than focus on the skills or critical success factors, some have pointed to the number of digital transformation projects themselves as a proxy for digital transformation maturity.

EPRI's experience has been that merely conducting many projects is not necessarily a reflection of maturity – the organization could still be operating within its silos and incurring technical debt (contributing aspects such as software not updated to current versions, unsupported technologies, or unpatched security vulnerabilities), because the investments are not coordinated.

When selecting qualitative characteristics and attributes, it is a good practice to pick categories that include people, processes, and technologies. But there are other facets associated with people and process that should be considered. To this end, four qualitative categories were selected:

- Collaboration & Coordination (Strategy)
- Organization (People)
- Performance Measurement
- Technology

A strategy that aligns these categories supports the collaboration and coordination needed for successful digital transformation within an organization. A strategy indicates intentionality, rather than "accidental" transformation. The "people" part is reflected in the organization category – not only the people doing the work, but also how they are organized, and characteristics related to training, retention, and recruitment. The performance measurement category is more in-depth. It reflects the metrics and benchmarks required for an organization to measure progress against their stated goals. Finally, the technology category is not limited to traditional IT-related domains, but also needs to reflect the technologies required by utility operations to maintain resilience and reliability on a day-to-day basis.

Maturity Levels

The maturity levels chosen for this model reflect, in part, their heritage from the Capability Maturity Model Integration (CMMI) process model [6], and some clarity on the broad description of the types of maturity seen at these levels. They include: [6]

- ***Level 1 – Ad Hoc:*** There may be some places in the organization where good things are happening, but this is limited to an organizational silo or reflect "heroic" efforts of a few people.
- ***Level 2 – Emerging:*** There is some awareness of maturity gaps and the organization is beginning steps to address the challenges on a broader scope.
- ***Level 3 – Defined:*** Processes, practices, and expectations are defined and the organization begins to execute on strategy and align initiatives.
- ***Level 4 – Quantitatively Managed:*** Changes reflect data-driven management, not based on "gut feelings" or assumptions. Changes are driven by measured value.

- ***Level 5 – Optimizing:*** This is where the organization begins to continually re-think how it executes initiatives. Organizations at this level have industry leading practices and others look to them to see "how it is done."

Each of the categories and the attributes are listed in the appendix.

How to use the Model

Ideally, the model can be used as a vehicle for collaboration and communication across a wide range of stakeholders. However, to get the most value out of the model, the process requires two steps:

1. Consensus survey
2. Aspirations setting

Consensus Survey

In the consensus survey, subject matter experts that represent the different domains, including information technology and operations, are convened, as well as people who can influence other aspects of the model, such as those charged with developing strategy or those who can shape the organization via realignment. Each category and respective attributes are then reviewed to paint a picture of the current organization status relative to these attributes (not what is planned). Effort should be made to identify any systems or processes that exemplify a given attribute. This process establishes the baseline maturity for the organization.

Aspirations Setting

Once the baseline is established, the same stakeholders are convened to determine what is to be done, if anything. Participants should be cautioned about choosing an action that might reflect a higher level of maturity "just because." Successful change efforts require an understanding of the "why" behind a change, along with any actions or obstacles, and the area responsible for leading the change. In short, one needs to know MOAR (pronounced "more").

- ***Motivation*** – the why behind any proposed change, identifying the perceived business value.
- ***Obstacles*** – although unforeseen obstacles might arise, stakeholders usually can identify issues that will need to be resolved for a change to be successful.
- ***Actions*** – what actions need to be taken to complete the change and to address identified obstacles.
- ***Responsibility*** – what team in the organization needs to take the lead on the change. This is not to say that they won't need to collaborate with others, but usually a single group needs to take the lead on a change.

Finally, a time frame needs to be set for the changes. The goals identified from the workshop need to be timebound to make them more actionable.

Further Research

This is the first version of this digital transformation maturity model. Although it has been refined by feedback from the three workshops noted, the development of a robust model requires that it be put in practice. Every viewer and subject matter expert sheds additional light on the meaning of the qualitative results. The more times the workshops are conducted, additional examples of good practices are identified. Also, it may be counterintuitive, but a more concise model usually is better. Identifying attributes that most succinctly are equated with organizational maturity within a company will lead to successful digital transformation efforts. A more concise model also supports conduct consensus and aspirational workshops, which helps achieve desired result -- identifying the critical success factors for digital transformation and creating an action plan to implement them.

Appendix – Digital Transformation Maturity Model: Categories and Attributes

Collaboration and Coordination (Strategy)

Level 1 – Ad hoc

- Individual-oriented and change resistant
- Operating in silos
- Ad hoc exchanges of information
- Proximity to potential shared interests
- No enterprise strategy for digital transformation
- Self-interest rather than enterprise interests
- Self/departmental interest supersedes enterprise goals/interests
- No collaborative projects exist (composition of project team 100% from either IT or OT, no mixing)

Level 2 – Emerging

- Small group-oriented and change-receptive
- Regular communication opportunities
- Tacit exchange of information
- Relationships and trust developing
- Grass roots collaboration exists informally
- Some teams work together
- Individuals are rewarded for reaching out on some teams, but other teams do not reward this behavior
- Informal collaboration, irregular communication
- Small groups collaborate
- Enterprise collaboration goals in place at small group or teams, but not enterprise level
- Cross-functional participation between teams
- Some projects can be identified that involve both IT and OT teams

Level 3 – Defined

- Division-oriented and proactively engaged
- Exploring collaborative opportunities
- Effective communication strategy mechanisms are in place
- Leadership and support structure in place for collaboration
- Written enterprise strategy or goals are in place (doesn't mean that all teams are supportive)
- Defined goals at a corporate level but not measuring or proving following goals
- Corporate strategy is defined but departments and individuals do not have accountability to follow
- Tools such as Balanced Scorecard are employed to tie activities to strategy

Level 4 – Quantitatively Managed

- Employees empowered and engaged with enterprise-wide collaboration
- Clear collaborative goals and objectives established
- Agreed network processes and working practices
- Exploring delivery mechanisms and partners
- Individuals and teams forgo personal "pet" projects in order to better support organizational initiatives
- Goals/strategy is defined, and most individuals and departments are achieving
- Strategies are mapped to business capabilities

Level 5 – Optimizing (Industry Leading)

- Pervasive throughout organization, adaptive collaboration mindset
- Creative, innovative, and experimentation culture
- Permanent network staffing
- Feedback/improvement/OODA loop exists that provides feedback and improvement opportunities
- Accountability to participate and implement the strategy (Specific Measurable Achievable Realistic Timebound, or SMART goals)
- Continuous improvement plan exists and is implemented at least annually
- Departments and individuals are empowered and have a process to give strategic input/ideas
- Ability to innovate and deliver competitive advantages despite competition or environment
- Strategy iterates rapidly in response to competitive opportunities and threats

Organization (People)

Level 1 – Ad hoc

- Non-cohesive culture; cliques
- Decision making "in-flight"
- Leadership structure vague
- Operation model undefined
- High employee turnover
- Ad hoc processes exist; no governance or consistency
- No awareness of diversity and inclusion issues
- No cross-functional teams
- No blended IT/OT skills
- Relationships between stakeholders are siloed and may be adversarial

Level 2 – Emerging

- Multiple local cultures, leadership structures and operation models

- Local decision-making
- Employee turnover is raised as an alignment issue
- Low level of understanding resulting in over analysis and stalled progress
- Success depends on individuals and management system supports
- Documented processes exist but full compliance is lacking
- Aware of the need for diversity and inclusion
- Aware of the need for cross-functional teams
- Recognize the need to have blended IT/OT skills
- Many "shadow organizations" but they are aligned
- A "digital champion" is identified

Level 3 – Defined

- Similar local cultures
- Local decision making based on corporate strategy - culture of innovation
- Local leadership linked to corporate leadership team
- Corporate operation model pushed down to local level
- Stable employee base, at or below industry average
- Defined methodologies and processes that support cultural and organizational change
- Teams work together as an integrated unit
- Success is measured collectively and not individually
- Work processes are followed autocratically
- Diversity and inclusion training are mandatory across the organization
- Jobs families defined across IT/OT
- Reduction in the number of shadow organizations

Level 4 – Quantitatively Managed

- Cohesive corporate culture and operational model
- "Failing fast" is encouraged
- Corporate strategy drives operational tactics
- Corporate leadership team coaches and empowers local leaders
- Employees recruited and retained based on strategic direction
- Strategic processes in place to assess, revise, and drive organizational best practices
- Collaboration exists with delegation of responsibility both internally and externally
- People are self-directed/empowered
- Integrated digital transformation management systems deployed cross-functionally
- A diversity and inclusion officer exists at the company and leadership promotes diversity and inclusion programs
- Recruiting, training, and hiring staff for blend IT/OT skills
- Have the "right" amount of redundancy
- Effective leadership - leader understands business needs in both IT and OT
- Specialists and outsourcing are used strategically

Level 5 – Optimizing (Industry Leading)

- Culture adapts strategically
- Operation model changes dynamically based on corporate strategy
- Professionals complete to work for corporation
- Leadership led with a high level of understanding, and full acceptance across the organization
- People feel empowered
- Continuous improvement of work processes for digital transformation
- The organization reflects its diversity and inclusion goals
- Employees have blended IT/OT skills
- Governance committee structure is centralized and staffed with all stakeholders
- Percentage of fund allocated to innovation and higher risk projects
- Accept and manage business risks based on a return on investment (ROI) model
- Governance is based on safety and reliability
- The right decisions are made at the right levels
- Open to disruptive technology prompting reorganizations

Performance Measurement

Level 1 – Ad hoc

- There is little or no performance data
- Metrics do not exist within the company

- Service/help desks do not exist or exist in isolation
- What is benchmarking?
- Multiple network operations centers (NOCs)
- Systems and labor costs are not known
- Many metrics – which are the "right" ones?

Level 2 – Emerging

- There are some facts and data, but their collection and usage are ad hoc, sporadic, and uncoordinated
- Reports and dashboards with some useful information is collected, for example customer data
- Metrics exist within the company but are not aligned; they are financially oriented and do not drive performance
- Benchmarking and research are inconsistent
- Performance improves in distinct pockets of the enterprise only

Level 3 – Defined

- Performance data is used in a coordinated fashion to gain new insights that improve operational decision-making
- Metrics are cross-functional, process-based, and supply chain wide; they are linked to overall business objectives
- Gathering process provides consistent and timely information
- Data lake/data marts may begin to be employed
- Internal metrics defined collected and used by management
- Benchmarking and research occur in most departments

Level 4 – Quantitatively Managed

- Performance data is used in a coordinated fashion to gain new knowledge that leads to improved operational and strategic decision-making
- Metrics are set and monitored in real-time among supply chain partners; key performance indices (KPIs) and balanced scorecard systems are deployed
- Increased visibility and transparency around relevant information; for instance, service-level agreements (SLAs), operational performance levels (OPL)
- Internal metrics mapped to customer satisfaction
- Benchmarking and research are consistent across all departments
- Customer satisfaction is used for continuous improvement
- Predictable ROI and growth, and measurable operational improvements

Level 5 – Optimizing (Industry Leading)

- Performance data is used to make operational and strategic decisions and to develop strategic foresight and predictions for the future
- Metric system continually monitors and responds to the environment combining prediction, optimization, and adaptability; for instance, using artificial intelligence (AI)
- Robust reports and KPIs provide highly focused insights
- Collaborative metrics are aggregated both internally and externally
- Benchmarking and research are optimized and monitored; Data quality is tracked and constantly improving
- Metrics drive good results (ineffective metrics are eliminated)
- Metrics drive long term strategy/goals/investments
- Predictive data growth

Technology

Level 1 – Ad hoc

- Maintenance of existing technology is lacking
- Sprawl of networks - proprietary, modified
- "Run to failure" mode of operation
- Minimal and unstable infrastructure
- Islands of data in workstations, servers
- New technologies are evaluated on an ad hoc basis
- Data integration is proprietary/run to failure, for instance cut maintenance, let maintenance lag
- No preventative maintenance – reactive support only
- Best of breed vs. suite solutions
- No strategic tool integration
- Asset management non-existent
- IT standards don't account for operations technology requirements

Level 2 – Emerging

- Stable but introduction of new technology is deemed risky
- Industrial networks use IP and Ethernet/IP
- Minimal convergence to enterprise IT
- Reduced industrial network downtime
- OT connectivity standards, specs used
- Minimal network visibility and structured support

- Security holes
- Minimum compliance with security standards
- Sporadic and ineffective planning
- Some data integration standards being used
- Some costs for technical/architecture debt are known
- ITIL like processes are used in many areas
- Technology is leveraged within an overall enterprise architecture

Level 3 – Defined

- Both operations and IT networks use TCP/IP as foundation
- Industrial "demilitarized zones (DMZs)" for both IT and operations networks
- Physical layer standards and specifications from enterprise to operations
- Use of proprietary data integration standards requires exemption/exception approval – costs/debt required to be calculated whenever used
- Siloed NOCs
- Beginning to take advantage of AI/machine learning technologies

Level 4 – Quantitatively Managed

- New technology introduction is prioritized by value
- Stable infrastructure reduces downtime
- Annual planning for physical network
- Predictive failure analysis
- Self-healing capabilities/automated support
- Technology R&D is coordinated across operations and IT with shared results and shared updates to corporate data, communication, and integration standards
- Wired and wireless infrastructure using IP for internet of things (IoT) and connected enterprise value
- End-to-end monitoring in a NOC
- Point solutions are integrated

Level 5 – Optimizing (Industry Leading)

- Leading-edge technology deployed as competitive advantage
- Scalable infrastructure for OT and IT to deliver mobility, edge compute, video, and cloud service access
- Virtualization and compute services evolve for timely data
- Predictive awareness of network health and security
- Annual planning for holistic network
- Proactive visibility and remote experts capable
- Forecasting future needs and option and defining future tech architecture
- Proactive maintenance exists at the right level
- Technology covers entire life cycle of technologies
- Technology choices (standards) are optimized - point solutions are used, but most solutions are enterprise
- Software and hardware assets for all areas are centrally tracked and data is used to support many important business processes (for instance, preventive maintenance, patching, risk analysis, vulnerability assessment)

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