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The Perfect Power Prototype

The purpose of the IIT Perfect Power Prototype project is to develop and demonstrate a real-world, replicable model of a power system that cannot fail the consumer and open-source it to the industry.

Galvin Initiative

- Started by former Motorola Chairman Robert Galvin in response to the 2003 Northeast Blackout.
- The initiative's goal is to use the continuous improvement principles pioneered under Galvin to design and promote a power system that cannot fail the consumer, or "Perfect Power."

Continuous Improvement

- The Galvin Electricity Initiative is leveraging continuous improvement methods to instill a focus on customers and to spur innovation in the utility sector - DMAIC.
 - Aligning business strategy with the “Voice of the Customer
 - Metrics, determining what is critical to quality
 - Process mapping
 - FMEA
 - Rank failures based on severity and probability
 - Error proofing (prevent or mitigate consequences)

Metric	Discussion
<p>Interruptions as defined by the customer - loss of power, loss of a phase, power quality fluctuations, etc..</p>	<ul style="list-style-type: none"> • Measure interruptions/customer/year • Measure power quality • Measure economic impact • Measure overall impact – damaged equipment, lost product, lost productivity, etc....
<p>Service territory gross domestic product and jobs</p>	<p>A measure of the service territories economic health. Most utilities' growth depends on the economic viability of the region. Utilities can provide a competitive advantage through costs, esthetics, quality, reliability, emissions reduction, and other joint projects with their major cities.</p>
<p>Asset utilization</p>	<p>The ratio of actual kWh delivered divided by the theoretical capability of the asset (kW times 8760).</p>
<p>Carbon emissions</p>	<p>Reducing carbon footprint could mitigate the impact of pending economic constraints.</p>

IIT Strategic Priorities

- Optimize power reliability and quality,
- Manage energy costs by positioning for real time pricing and demand response,
- Build efficiency into all aspects of operation and maintenance of the energy system to improve life cycle costs, and
- Develop a more sustainable energy system.

DOE Office of Electricity Goals

- Strengthen grid stability
- Increase energy efficiency of delivery system
- Increase asset utilization
- Harden energy infrastructure

Critical to Quality (CTQs)

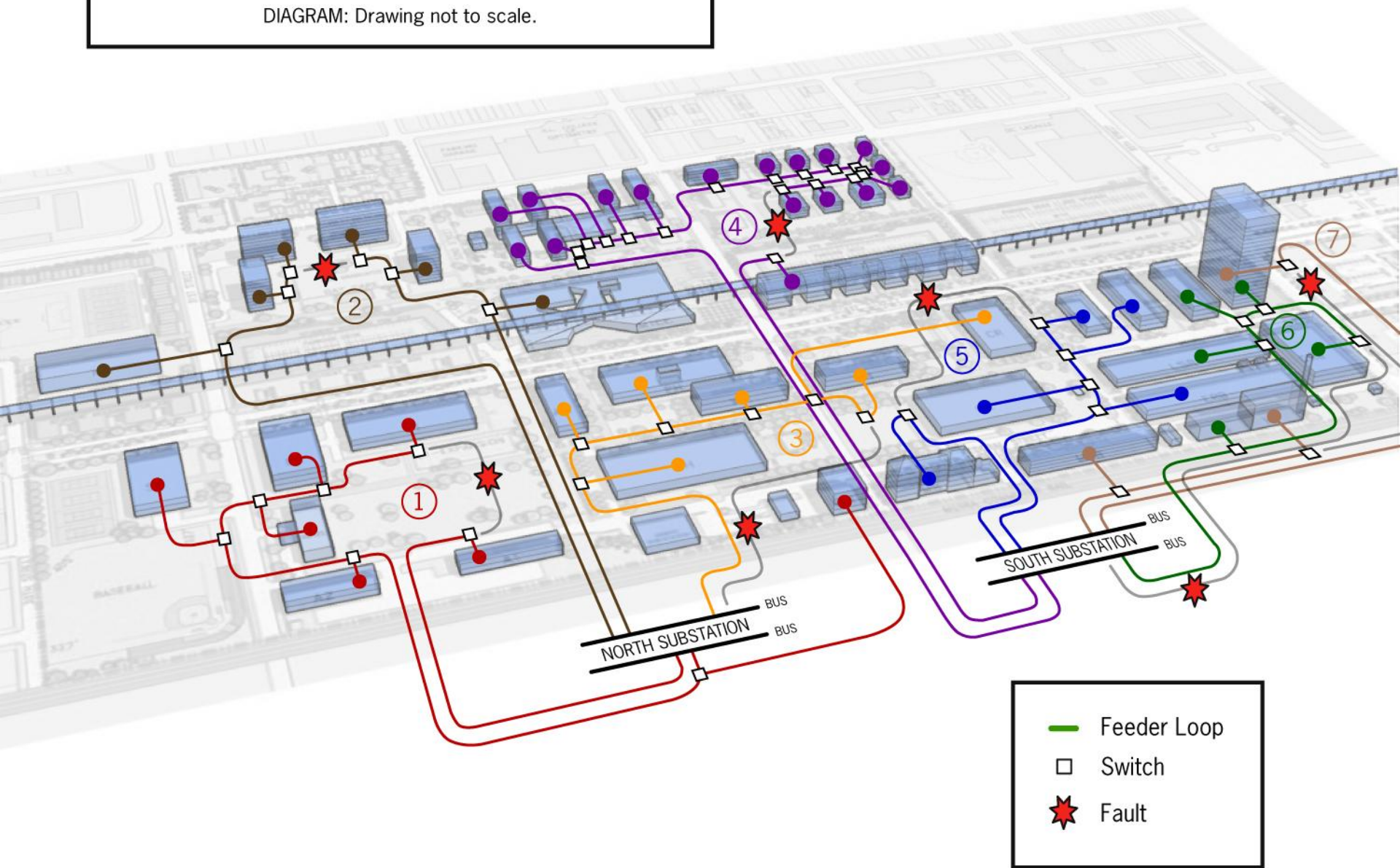
Voice of the Customer	Interpretation	CTQ
Lost experiment due to power outage	Faculty needs perfect power availability to support key research	100% reliable power
Run experiment at night due to power quality issues	Daytime power quality is insufficient	Power quality
Lack of infrastructure to support new research	Insufficient power and cooling for new research activities	Capacity

Perfect Power Elements

- Protect supply – underground, new cable,
- Redundancy - High Reliability Distribution Concept
- Backup Power/Demand Response
 - Building Integrated Power Systems
- Perfect Power Foundation/Technology Ready Infrastructure
 - Automated switches and coordination with advanced communication
 - Upgrade building transformers
 - Replace remaining 5kV feeds with 15kV cables
- Self Healing/Distributed Intelligence
- Master Controller, Intelligent Monitoring, and Trending
- Ancillary Services
- Improved Sustainability – EE, RE, etc...

High Reliability Distribution System:

DIAGRAM: Drawing not to scale.



BIPS

- Local generation to carry the building load for an extended distribution system outage
- UPS/storage to provide electricity while the local generation is starting
- Inverters or power quality conditioning devices
- A load controller to modulate the generator output to gradually unload the UPS and to follow the building loads
- Motor soft start capability for large motor loads such as elevators
- Non-critical load shedding capabilities
- Communication to the campus master controller (probably through a building-level master controller)

Master Controller

- Monitor external and internal conditions and put the site into the appropriate mode of operation
 - Normal, island, safe
- Starting and stopping local generators and storage devices
- Controlling local loads based on predetermined sequence of operation and load reduction priority scheme
- Automatic switching of loads to alternate transformers, campus feeds, and substations.

Perfect Power Value

- Reliability/Power Quality
- Real time pricing
 - IIT could purchase electricity from the real time markets and deploy its backup generation when the price of electricity exceeded 7 to 8 cents/kWh
- Spinning reserve
 - In 2006 there were 19 events in the Chicago area valued at \$10,000/event/MW
- Day ahead economic load response
 - The PJM ISO in the Chicago area called for demand reduction for about 1000 hours providing up to \$200,000/MW for the year

Utility Opportunity

- Can identify and prioritize critical customers, facilities critical to life safety, and customers experiencing greater than X disruptions/customer/year
- Can initiate a Perfect Power program to increase reliability
- Can work with the regulatory commission to create mechanisms for valuing Perfect Power
- Can gain access to valuable ancillary services and grid stabilizing assets

Steps to Perfect Power

- Define – Voice of the Customer, Critical to Quality
- Measure quality – AMI, impact of interruptions
- Assess – FMEA
- Improve – Error proofing
- Control – Monitor performance