Electric Grids And DC (Distributed Computing)

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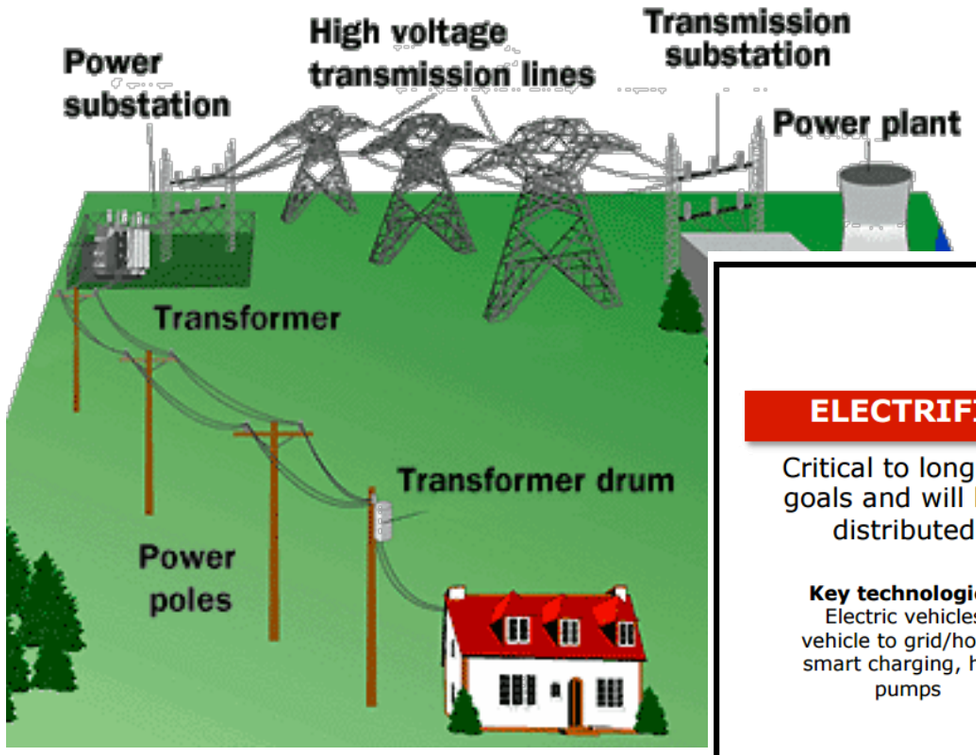
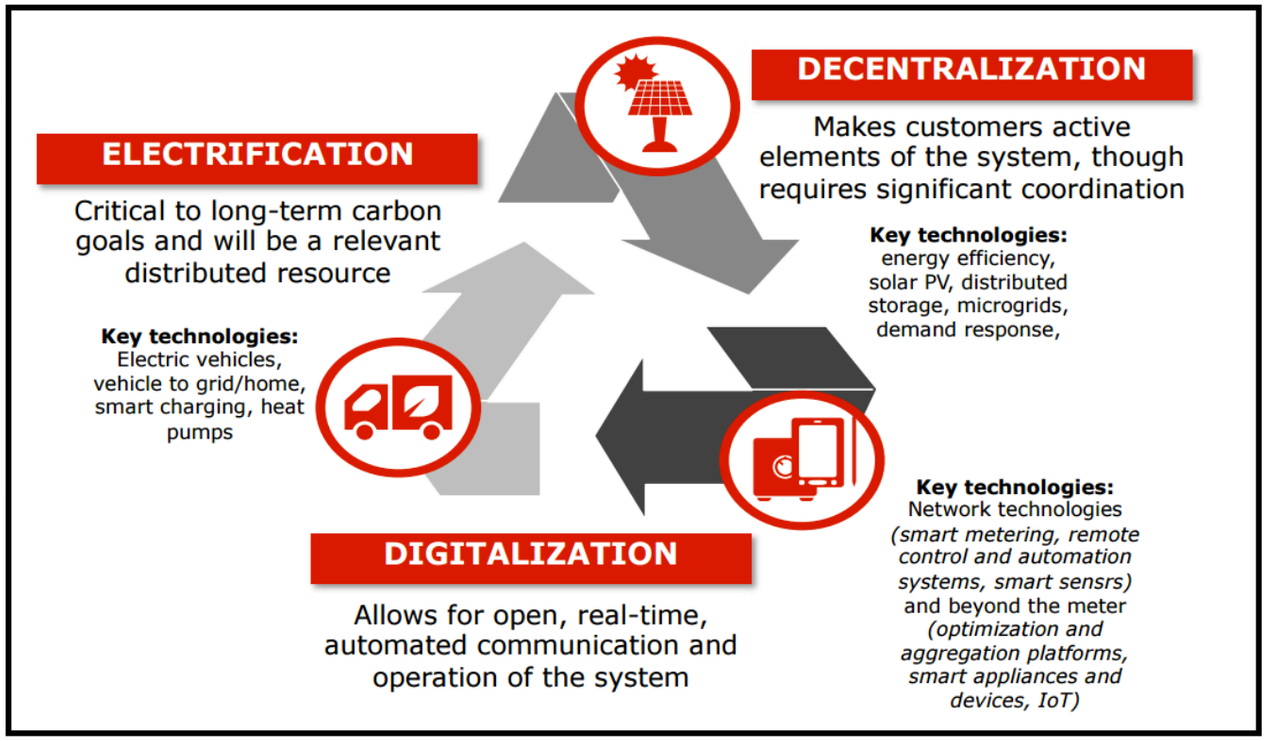
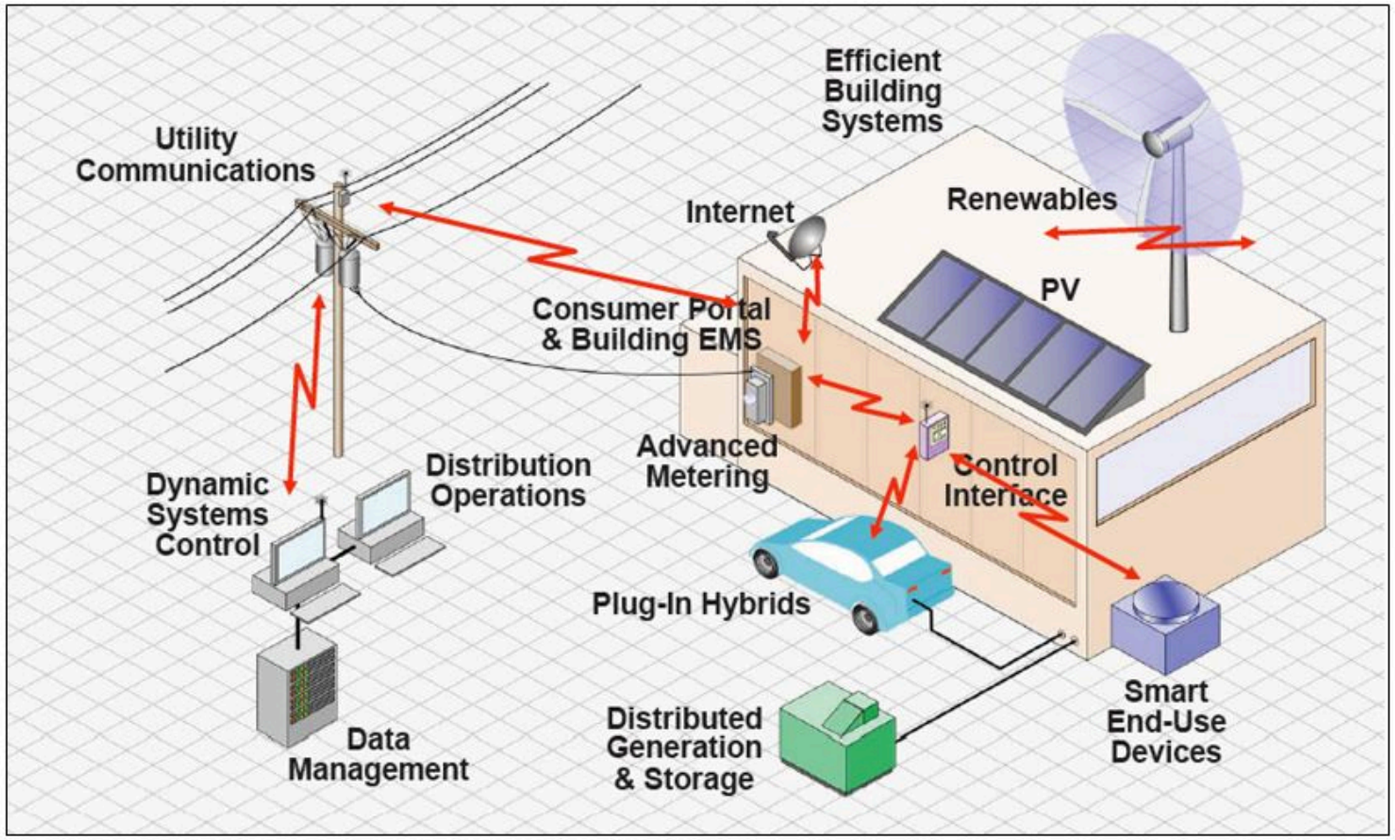
Standard Disclaimer: individual opinions only

Centralized System





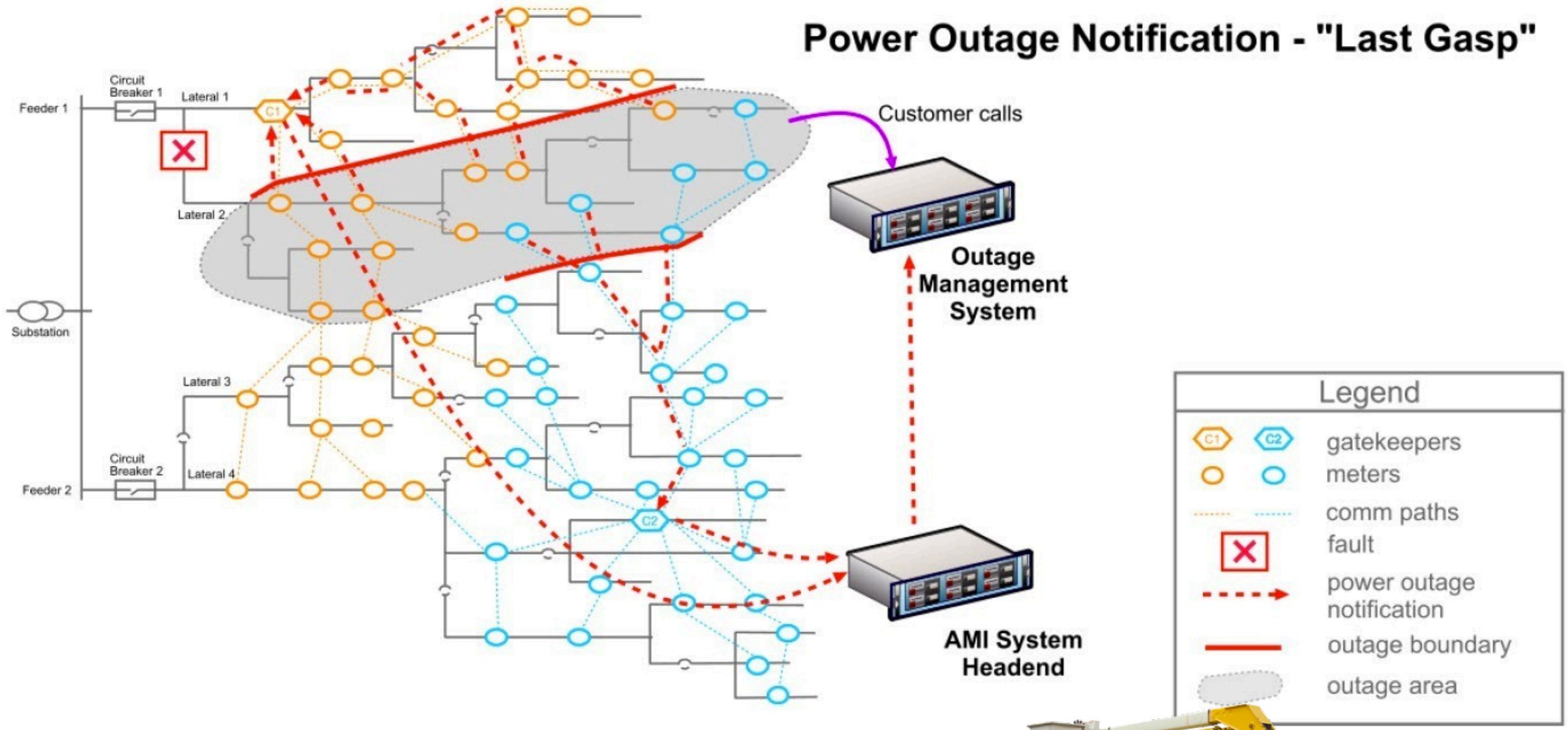
EdgeBased



Where is the power out? From Phone Calls To <= 5 Million Messages

Flow of Smart Meter Power Outage Messages

Smart meters are generally capable of notifying the utility of the scope and boundary of power outages.



Credit: Image adpated from Figure 4 of Elster Document WP42-1002A

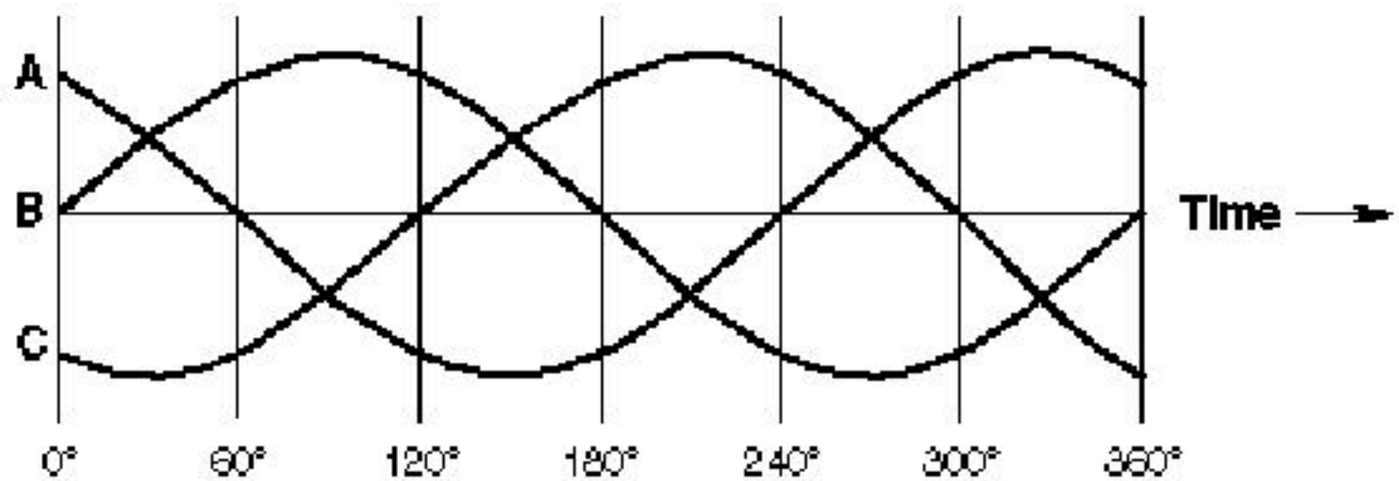
Where is the power restored?

3 Phase AC Power

Each phase is displace 120°

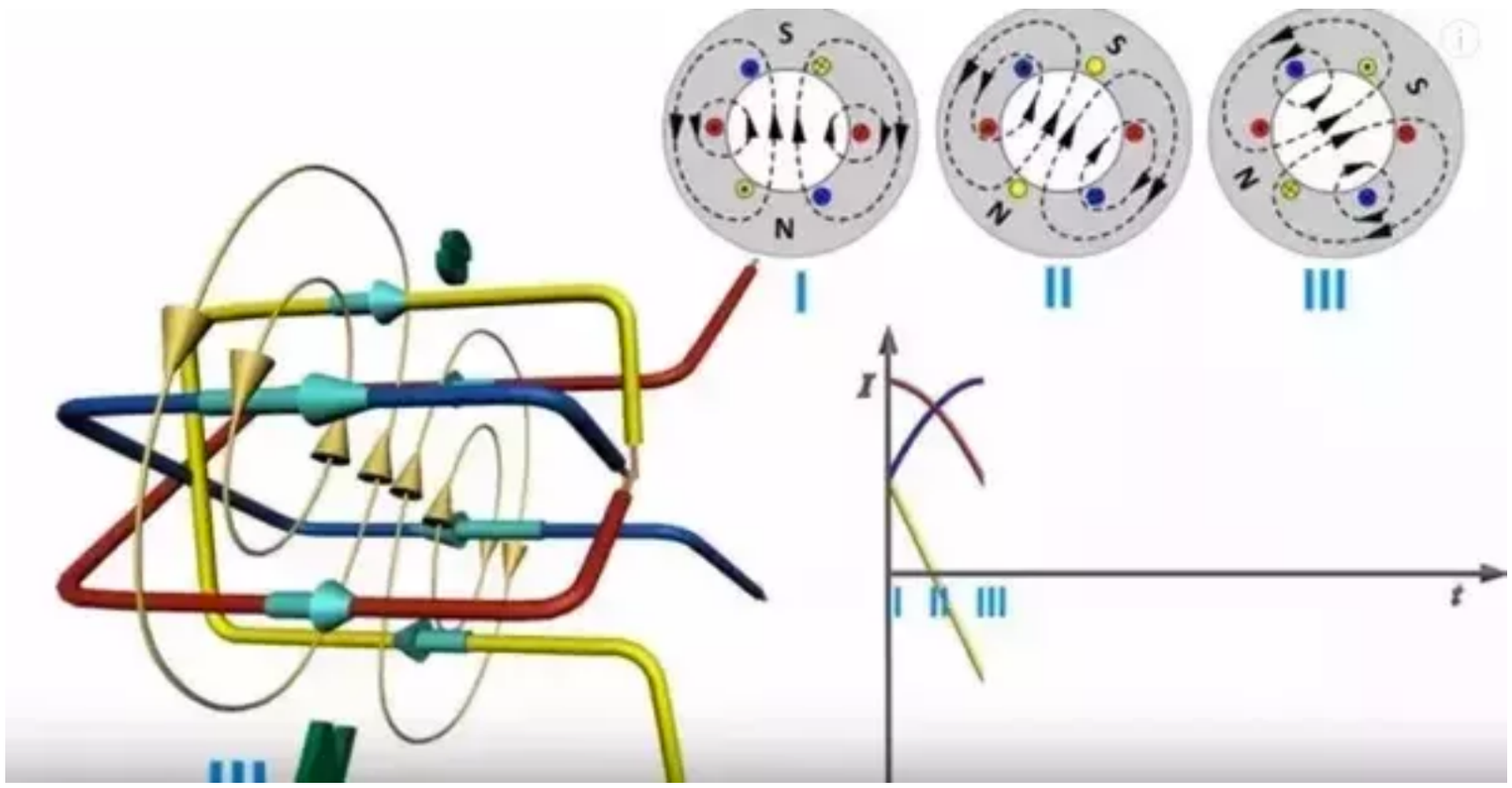
Frequency - defines how many times a second AC changes direction: from positive to negative

Voltage - defines the amplitude of electric power



Note: US Standard = 60 cycles per second (60 Hz)

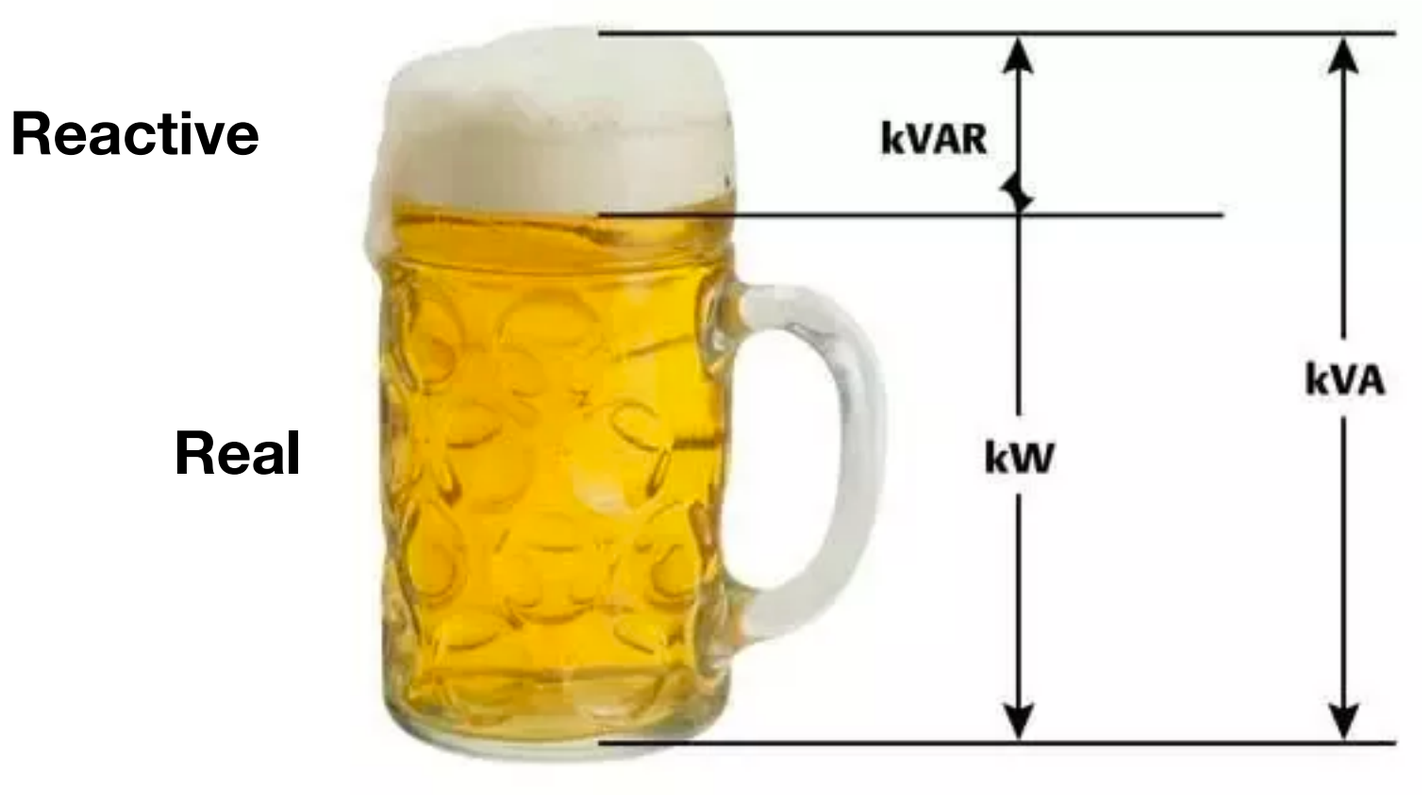
Electrical Phases & AC Motors



“Now in three phase we have alternating current displaced by 120 degree. Just consider the three coils for now (R B Y) at an instant I the current flows as shown and magnetic field around it is as shown. However the current is AC and hence at another instant II the orientation will be different. SO on and so forth. So ultimately we have a rotating magnetic field and all we have to do is place a coil in the field and there will be electric current induced in the coil (electro magnetic induction) .. In the induction machine instead of just a coil we have a rotor, and this rotor current circulates with in and causes the rotor flux. The rotor flux interacts with stator flux and this interaction causes the net motion on the rotor.”

https://www.quora.com/Why-does-the-rotor-rotate-when-the-induction-motor-is-fed-from-3-phases

Electricity & Beer - Keys To Understanding



“Kinds of Power”: Real, Reactive, Apparent

"Real" power is power that does actual work - e.g: creating heat, turning motors

"Reactive power" is power where the current is out of phase with the voltage, and the "Volts x amps" doesn't do a work. Current that charges a capacitor, for example or current that creates the magnetic field around a coil for a

"Apparent power" is the mathematical combination of these two.

Frequency and load[edit]

The primary reason for accurate frequency control is to allow the flow of alternating current power from multiple generators through the network to be controlled. The trend in system frequency is a measure of mismatch between demand and generation, and is a necessary parameter for load control in interconnected systems.

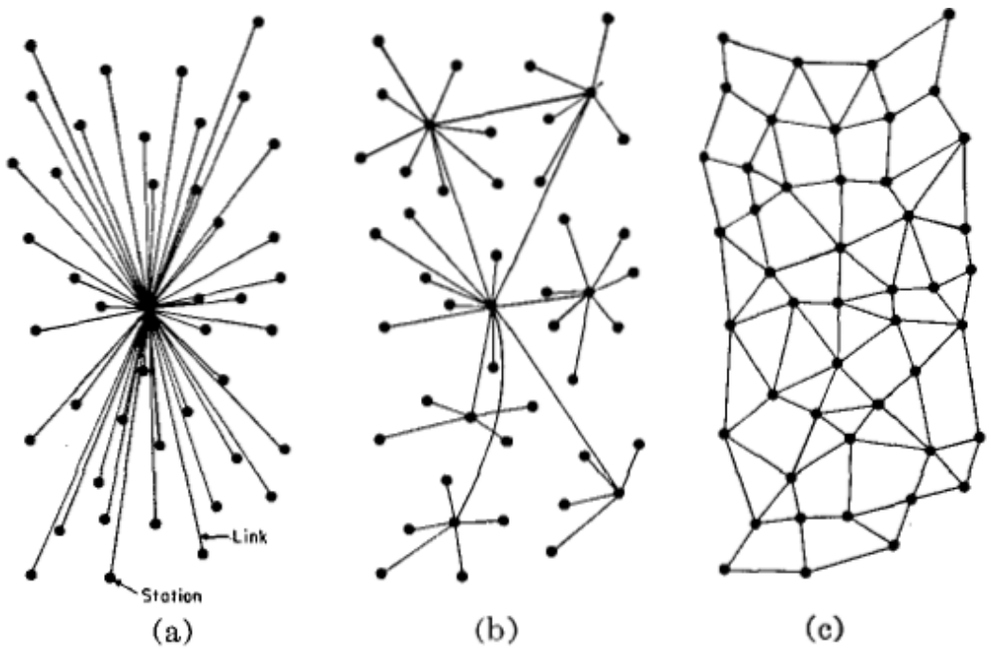
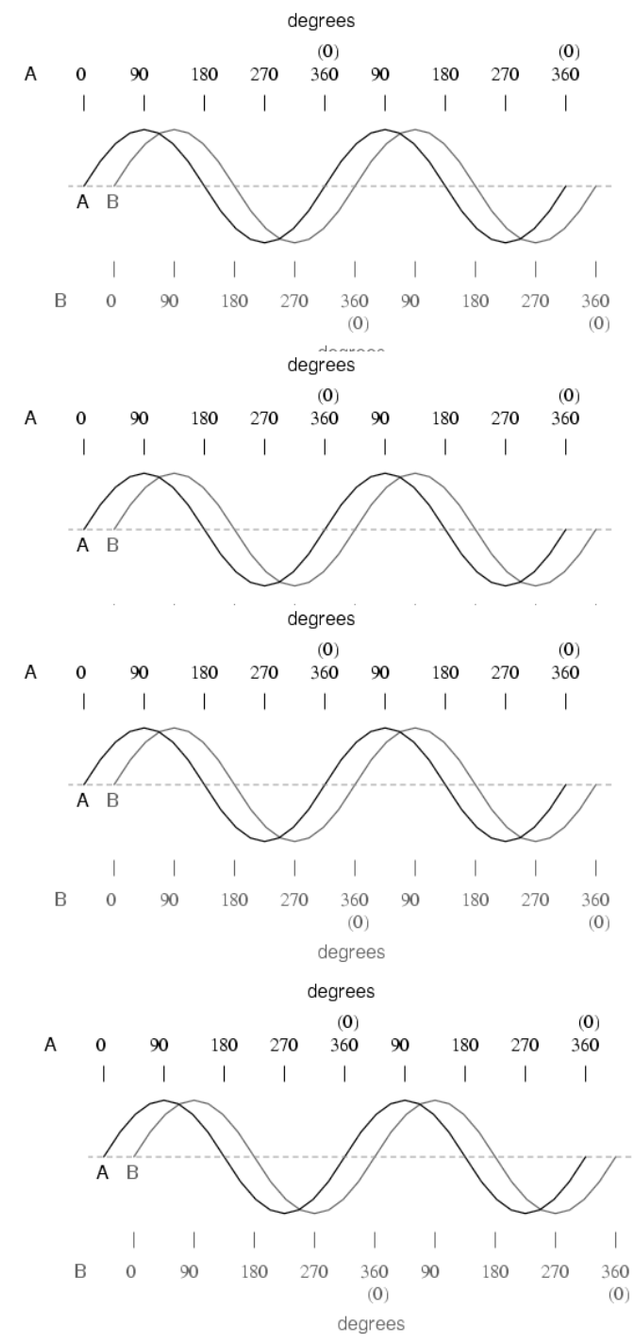
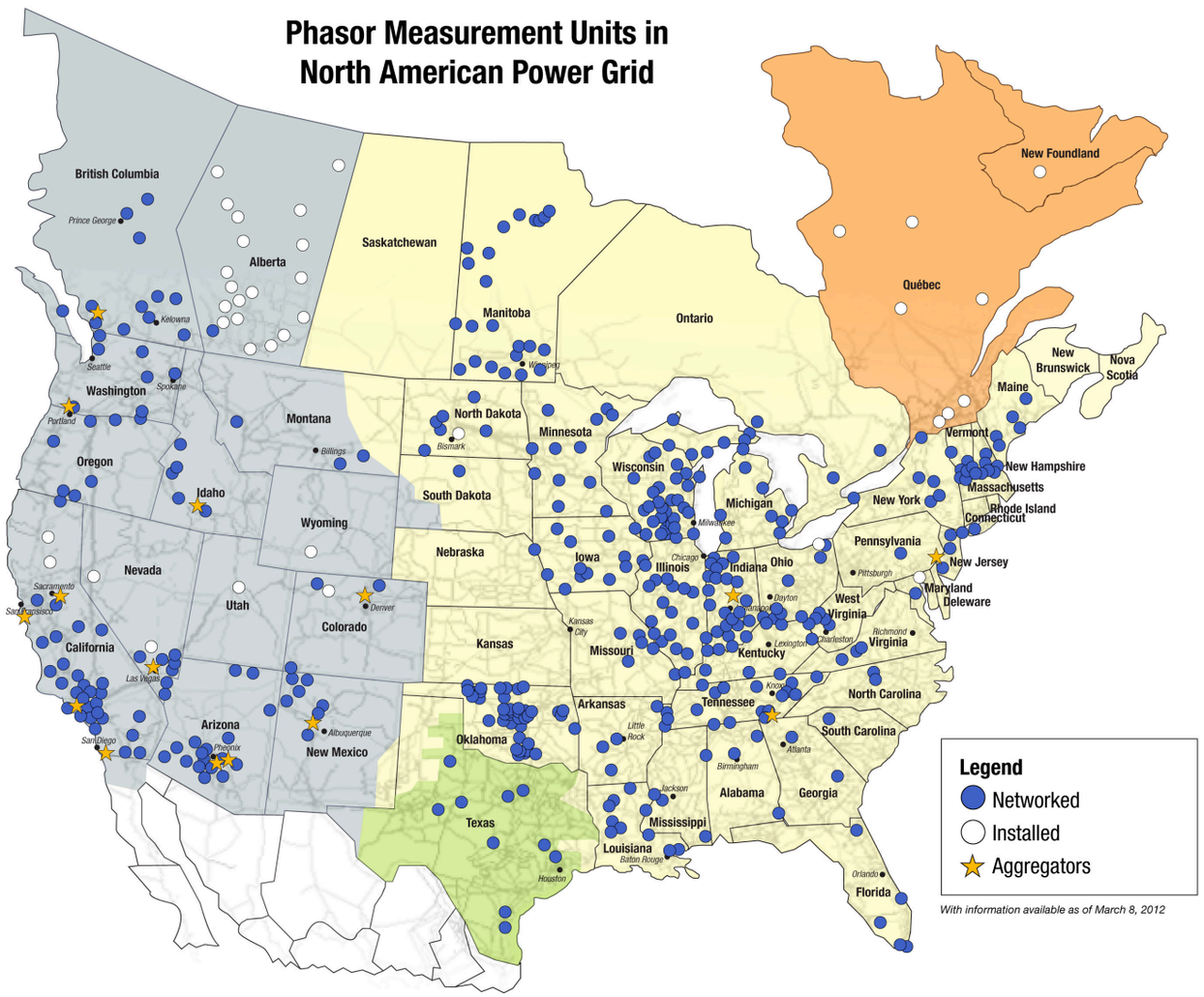


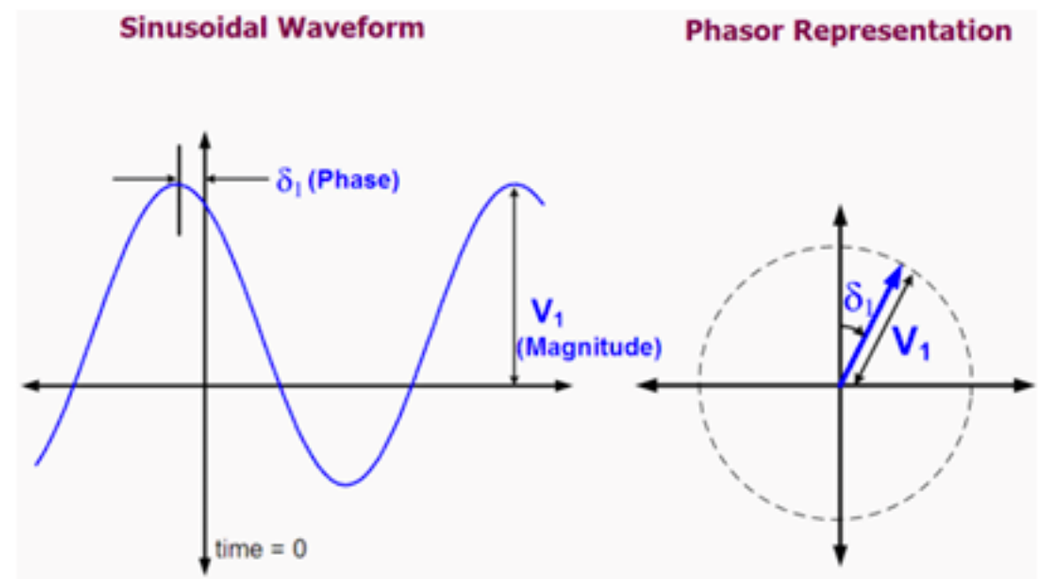
Fig. 1—(a) Centralized. (b) Decentralized. (c) Distributed networks.



SYNCHROPHASORS

Synchrophasors are time-synchronized numbers that represent both the magnitude and phase angle of the sine waves found in electricity, and are time-synchronized for accuracy. They are measured by high-speed monitors called Phasor Measurement Units (PMUs) that are 100 times faster than SCADA.





Conclusion(s): Plea for Help In Characterizing Useful Parallels

“Critical Infrastructure”

From Centralized/Hierarchical System Over Wide Area
to Distributed/Edge/Hierarchical Over WAN

Perspective Shifts + Grid inherently is Distributed/Edge System - ‘Generation is Catching Up’

Reasoning About - Systems @ Scale in Transition / Resilience By The Edge

Coordinated Frequency is Fundamental

Enabling Small Scale Local Coordination - Combining To Scale

Electric Vehicle Charging - Virtual Transformers

Time, Clocks, Frequencies, Causality, InPhase

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