

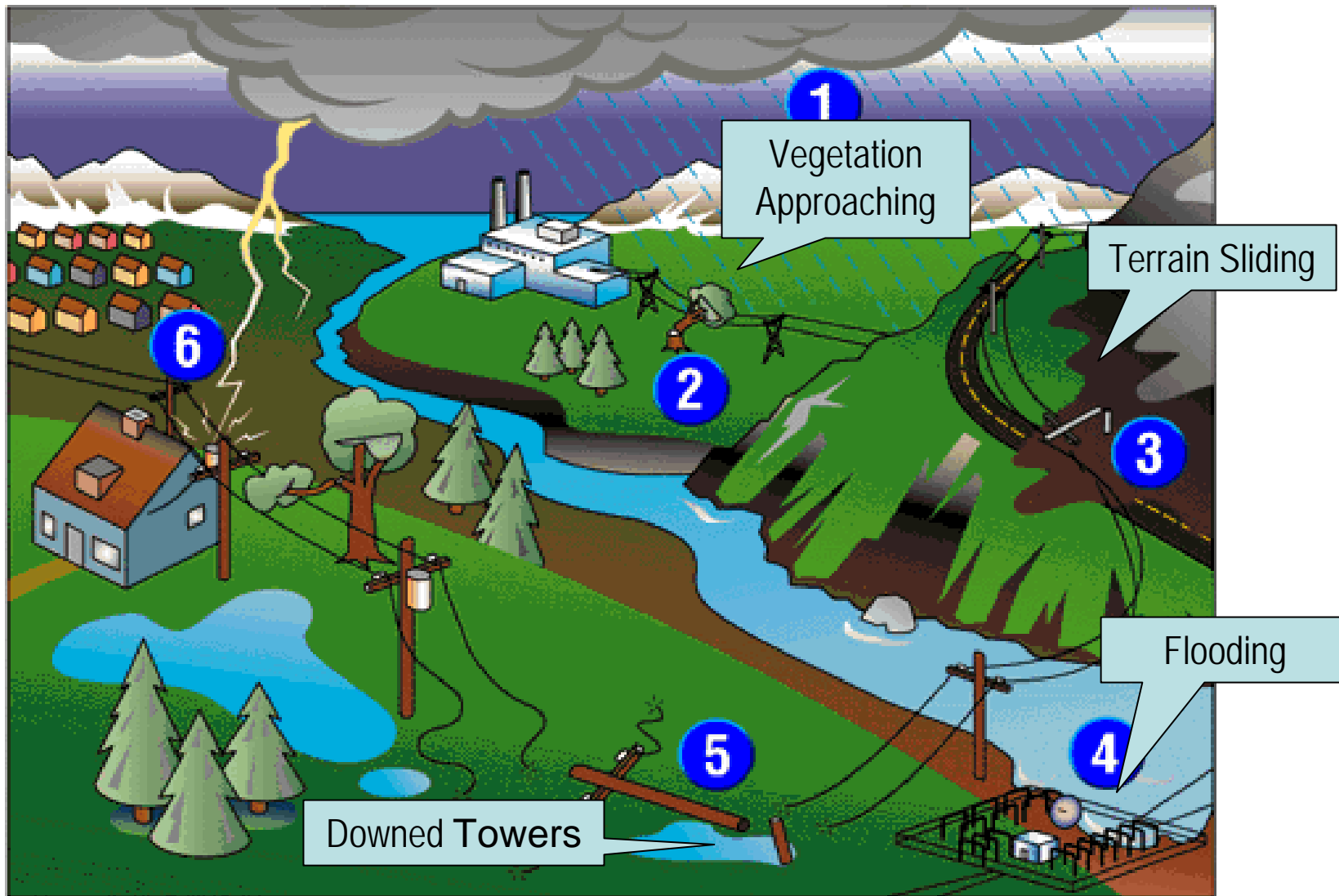
# Embedded Sensor Network for a Secure Electric Energy Infrastructure

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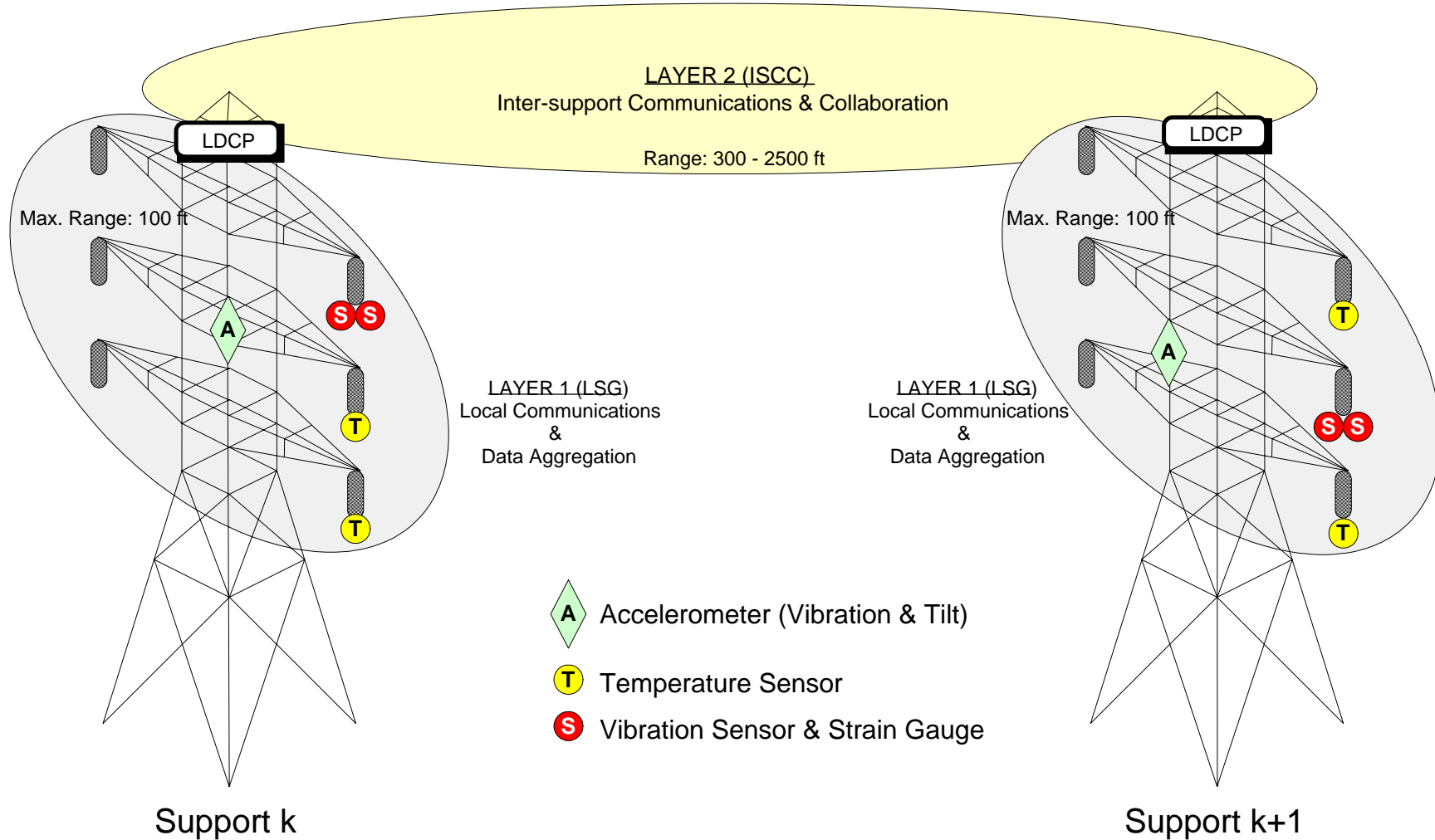
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# Natural events that affect electric infrastructure



# Embedded sensor network in transmission system



# Sensor application matrix

	<i>Tension/Strain</i>	<i>Vibration</i>	<i>Tilt</i>	<i>Temperature</i>		
<i>Normal Conditions</i>	Normal Values	Normal Values	Normal Values	Normal Values		
<i>Ice Accretion Low Wind</i>	Increased, inside Limits	Normal Values	Normal Values Very Small Angle	Normal Values		
<i>Medium - High Wind Bare Conductor</i>	Increased, inside Limits	High Frequency Inside Limits	Normal Values Very Small Angle	Normal Values		
		<i>Tension/Strain</i>	<i>Vibration</i>	<i>Tilt</i>	<i>Temperature</i>	
<i>Medium - High Wind Uniform Ice</i>	Incr Lim	<i>Explosion Blast</i>	Sharp Increase	Sharp Amplitude Increase	Oscillating Values	Temporary rise
<i>Galloping</i>	Incr valu	<i>Compromised Structure</i>	Increased in strain/dead-end supports  Loss of equilibrium in suspension supports	No Information	Apreciable Tilt 0-90 degrees	Normal Values
		<i>Collapsed Structure</i>	Sharp Increase, then goes to zero	No Information	Apreciable Tilt ~ 90 degrees	Normal Values
		<i>Hot Spots</i>	Normal Values	Normal Values	Normal Values	Isolated high temperature measurement
		<i>Overheating</i>	Increased strain caused by sagging	Normal Values	Normal Values	Uniform between conductors and nearby supports

# Research Challenges

- Embedded sensor network design
  - Real-time, reliability, security, and power considerations
  - Self-healing and self-configuring capabilities
- Distributed sensing and control
  - Latency and channel loss considerations, data synchronization
- Electro-Mechanical state estimation algorithms
  - Models of mechanical sensors
  - Rule based or model based estimation
- Enhanced power system application-level algorithms
  - Fault diagnosis, prevention/restoration strategies (e.g., islanding)
  - Power flow analysis, security analysis, vulnerability analysis
- Deployment and maintenance issues, cost-benefit analysis