Disaster Risk Resilient Planning for Energy Infrastructure: Issues and Challenges

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OVERVIEW OF PRESENTATION

- Indian Power Sector- An Evolving Sector
- Upcoming Large Renewable Energy mix of 175 GW by 2022 apart from existing 333GW
- Operational Scenario- Modified Drastically
- Associated design issues of installation and safety - based on the regional requirements
- Under natural calamities of varied magnitude in different regions of country specific, the design need to be undertaken modularly to avoid any untoward incidence and cascaded effects
- Region specific structural design issues and challenges in general have been taken as per standards laid down
- Global impact of disaster cannot be assessed apriori due to many factors having interdependencies

OVERVIEW OF PRESENTATION-Contd.

- Resilient Planning-coal mines, hydro dam location, water in feed to thermal plants and gas pipe lines
- In nuclear power plants, reactor location in general is near water bodies which sometimes are so crucial during Tsunami type disaster situations that may have an alert for plant operators and special risk factor may have to be included at planning stage itself
- An approach for assessment of underground earth dynamics at sensitive locations - Integrated Technology due to unequal forces responsible for equilibrium shift with Technology Integration by Satellite Imaging
- Normal Equilibrium Point Design for Power Infrastructure – As Reference for Analysis

- An alternate bypass methodology needs to be evolved for handling unprecedented cases
- In general disaster as on date has been viewed due to natural calamities only
- Whereas in today's evolving power sector having massive communication dependencies of control and operational requirements, may require existing system upgradation and new system planning to ensure failure free communication to drive the power sector effectively for national economy

This may require a new model of communication having dedicated corridor of power sector with National Power Satellite to cater the needs of communication.

It's well known that shifting masses send out shock waves that may be powerful enough to: alter surface of Earth, thrusting up cliffs and opening great cracks in the ground and cause great damage ... collapse of buildings and other man–made structures, broken power and gas lines (and the consequent fire), landslides, snow avalanches, tsunamis (giant sea waves) and volcanic eruptions.

- The classical mode of fibre optic communication may need to be upgraded or changed to accommodate the operational issues for massive power control requirement specially, all interconnected thermal, hydro, nuclear, gas and RES plants diversely located across the region.
- The recent incidence of cyber threats have endangered the operational safety of many sensitive control devices in power sector especially energy control centres at both state and central level.

- An example may be considered such as cyber threats affecting the consumer load patterns as such which may be fictitious other than the realistic situations on site
- This may be due to more load or less load creation by way of modulating the data base by hackers attack that may force the Grid operation in load shedding mode and generation shut down in case of less load viewed by fictitious data modulation
- It’s right time to integrate the security features in all upcoming new system (generation, transmission and distribution) to ensure no damage to interdependent infrastructure

- An integrated planning in interface sector of global power sector need to be taken up at earliest.
- Since disaster risk resilient planning cannot be viewed in isolation as piece peal, therefore an integrated planning considering the known historical disaster of respective regions/countries having local or global impact assessed so far must be brought in design stage itself.
- The communication related disaster management must be taken up immediately by all utilities/industries for ensuring the tolerance either in transmission and distribution infrastructure or upcoming RES system which may be cluster base or distributed as well.

- All RES plants power injection pattern may be a basis of upcoming Renewable Energy Management Centre (REMC), therefore the loss of signalling at dispatch centre may create chaos for existing conventional generation in terms of operational management
- Smart cities planning must ensure all such critical infrastructure safety and standards as they are backbone of entire asset at tale end.
- A new concept of upcoming micro grid need to be considered in Indian context with RES in form of roof top, solar and wind parks both at local and global levels

- This forms an important role of states and central owned companies in this sector due to the fact that all such large RES plants are interfaced in existing grid infrastructure and the point of connectivity is common
- A new model may be thought at earliest possible which comprise of VSC HVDC at micro grid capacity of 400MW or so
- All such large plants connectivity must be mandated with VSC HVDC connectivity to avoid any sudden loss of RES generation due to natural calamity or so.

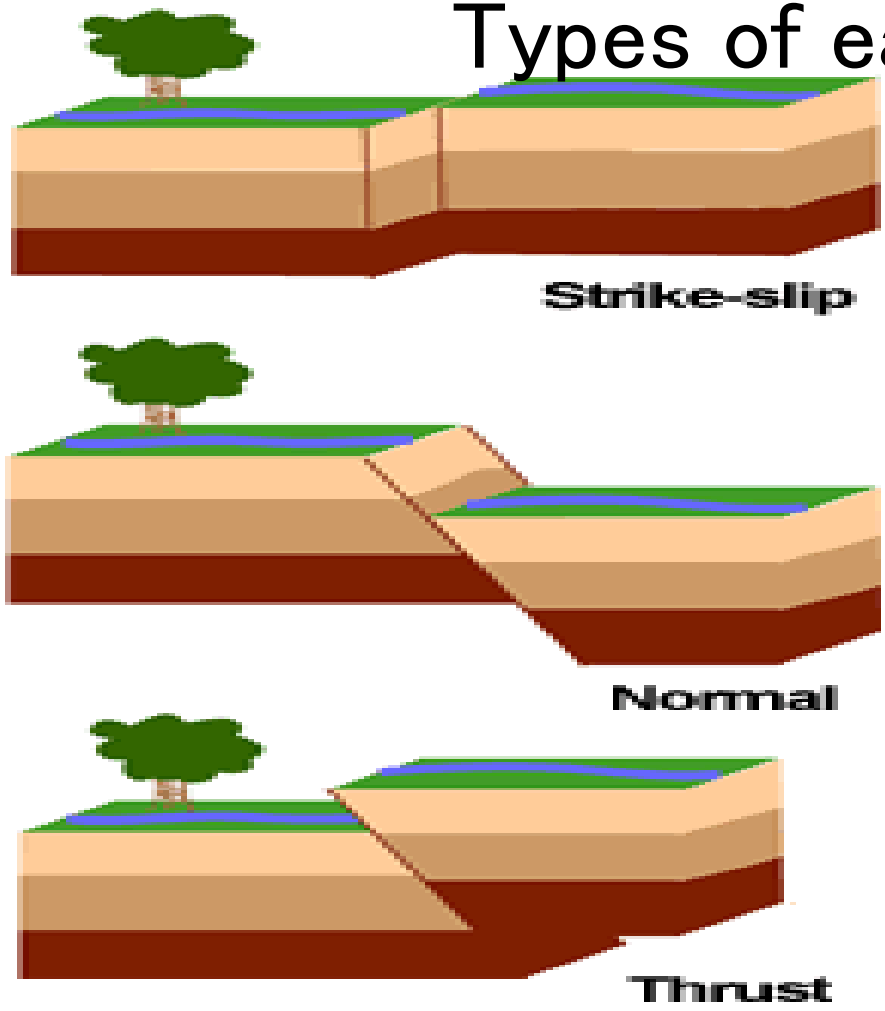
- This is not only going to provide a buffer isolation to reject the impact of sudden loss of generation but also load as well in huge capacity of existing grid
- The model of evacuating power of large wind mills through HVDC trunk lines need to be looked from operational view point as Effective Short Circuit Ratio of respective terminal may change due to sudden power loss by RES as natural disaster is observed
- The disaster can be mapped in Energy Infrastructure not only due to natural calamity such as Earth Quakes but also cyber security threats, absence of RES, grid operational issues and challenges need to be included in Planning criterion.

- With innovative approach It’s advised to have better and optimal integrated planning strategies not only to India but may be taken as role model for other countries with slight modifications based on local and regional factors.
- Disaster may be viewed jointly such as Natural Calamities and also Cyber Threats for upcoming Smart Energy Infrastructure in Totality.

Impact of Earthquake?

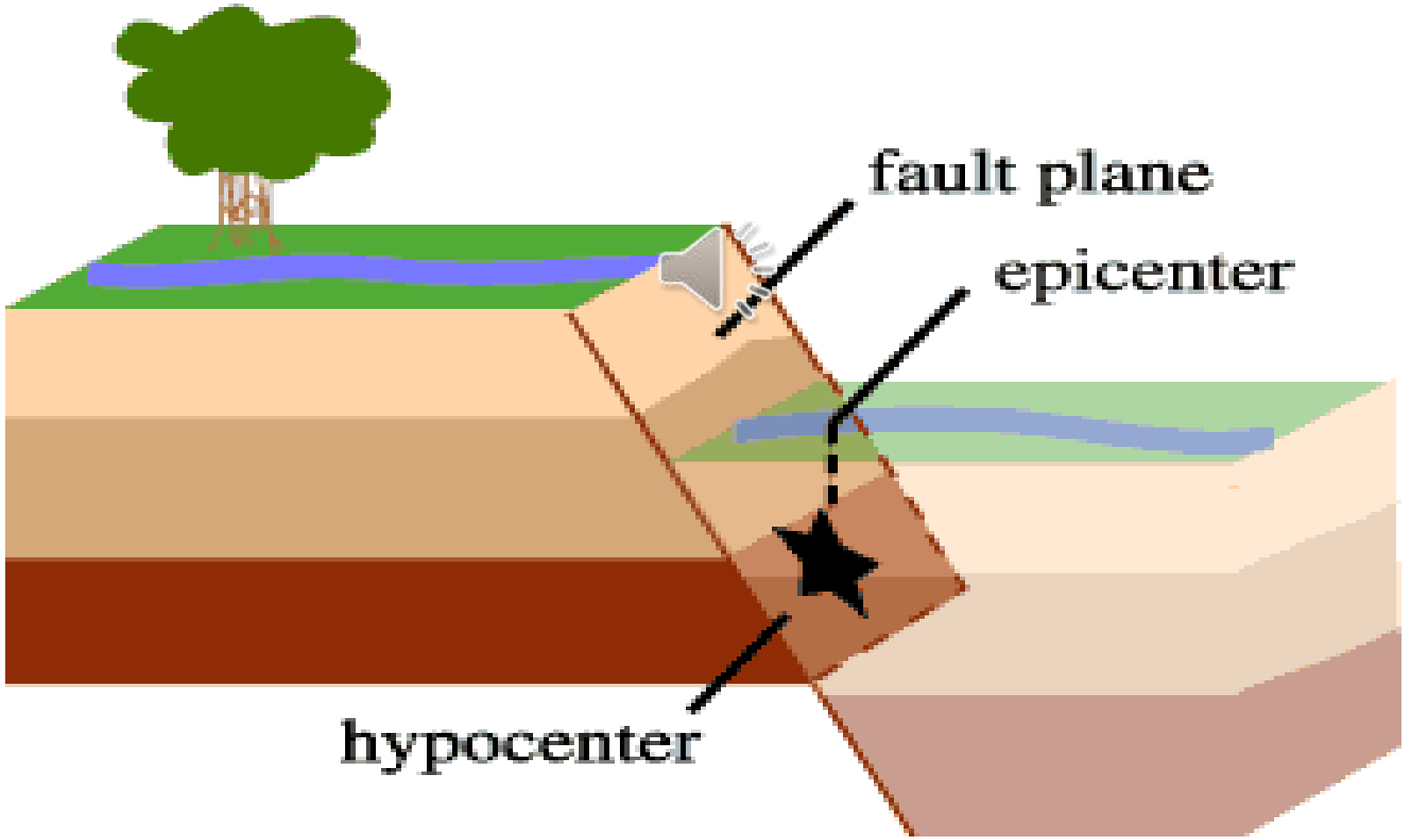
- An earthquake is a shaking of the ground caused by the sudden breaking and movement of large sections (tectonic plates) of the earth's rocky outermost crust.
- The edges of the tectonic plates are marked by faults (or fractures). Most earthquakes occur along the fault lines when the plates slide past each other or collide against each other.
- The Structural Planning of Energy Infrastructure must have minimum tolerance criterion for reliability

Types of earth movement:



- Strike Slip – the two plates rub against each other laterally
- Normal – one plate drops below the adjacent plate
- Thrust – one plate is pushed up above the adjacent plate.

Anatomy of a fault:



- **Earthquake Management Centers (EMC)**
  - At State, Regional and National /International level
    - Co-located with respective Earth Monitoring/ Despatch Centres
    - Coordination between the State / Regional / National/International Data Analytics Centre.
  - Integrated with real time measurement and information flow.
    - Visibility of the Zonal Earth status
    - Communication & IT infrastructure with adequate resilience and redundancy for assessment and alert signalling
  - **Interfacing with Indian Metrological Department (IMD) at local and global level.**
  - EMC may have following functions:
    - Real time tracking of Zonal Earth Dynamics with Satellite Imaging
    - Geo-spatial visualization
    - Advanced decision-making and Alert Initiation Building Block

liance to Safety Standards and Earth Equilibrium

- Enforcement of compliance to Earth Equilibrium standards – Signalling

Understanding Deviation Factor and associated Measures- Generation, Transmission and Distribution Infrastructures

- Zonal Satellite Imaging and Computation of Deviation Factor
- Data Analytics Algorithm Development
- Interfacing the Deviation Factor with Data Analytics tool
- Acceptable Deviation factor and risk of Relatively larger change Condition Monitoring
- Establishing a Thumb Rule for Deviation Factor of Equilibrium Prediction and signalling
- Parallel Data Analytics for Multi Zonal Earth behaviour with Satellite imaging

Need of Smart Devices and IoT Technology

- Expert system to supplement conventional Earth Data Flow : Visualize Earth Situational Image at Sub-Zonal level.
- Develop Tools to comprehend situational awareness and to derive corrective actions – Alert Signalling and associated impact analysis while contingencies are propagating
- Automation in Alarm Generation including recommended solutions

Evaluation Procedure for Degree of Risk - IoT with Satellite Imaging

- Device that send field data at sub-second having global Time synchronization.
- Visualization of Degree of Risk and Tectonic Measurement information Through Decentralized mode with Centralized Mapping and despatched data flow
- India needs to adopt the technology at Regional and national level as pilot and demo projects.

Real Time Earth Equilibrium Shift Monitoring with Smart Sensors Through IoT - An Ideal Framework for Earthquake Prediction

- Real Time Earth Equilibrium Shift Monitoring facilitates efficient and reliable end-to-end intelligent multi-way delivery system for Earthquake Prediction

- IoT will be able to facilitate and coordinate various zones for understanding the earth dynamics in real time
  - It can help in least loss with in time alarm and update the information monitoring system,

Need of Multi-Group for Earth Equilibrium Prediction & Planning

Earth Science Expert

- Knowledge Sharing
- **Process to Integrate Detailed Equilibrium Point at Multi-Zonal Level**
- Facilitate in Developing Algorithm of Data Analytics
- Brain Storming Analysis with Satellite Images
- Suggesting Remedial Solutions to Avoid Earth Quake

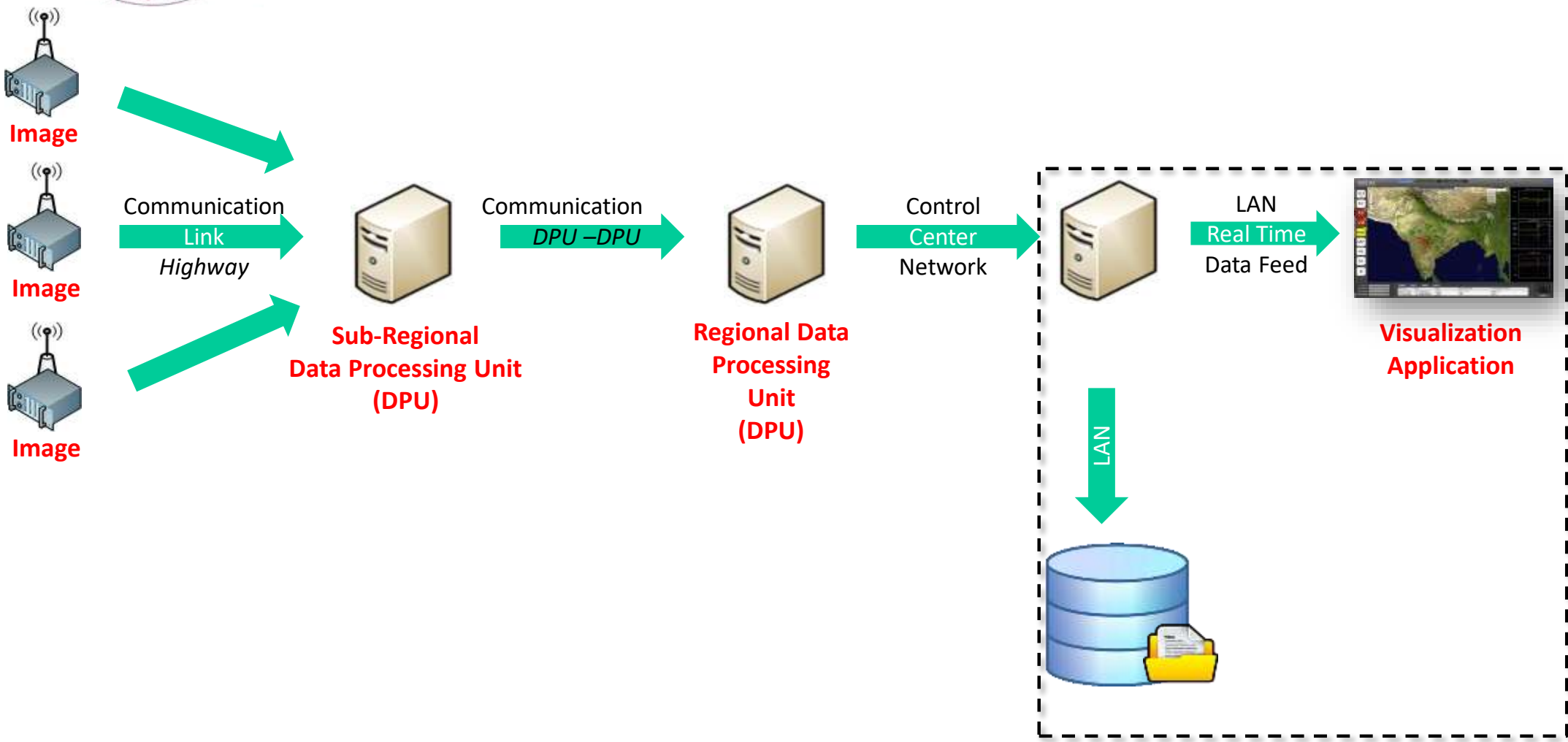
Satellite Imaging /Data Analytics

- Improved Visibility of appropriate Zone based on Deviation Factor
- Real time Risk Assessment and Alert Signalling
- Effective Monitoring and Alert Signal Generation
- Improved Earth Understanding
- Coordinated Zonal Earthquake Prediction Mechanism

Algorithm Development and Meteorological Linkage

- The data interface in algorithm and fast computational formulation
- Closest Coordination and Assessment Enhancement
- Risk Factor for Earthquake reduction

Integrated Information Highway for Satellite Imaging and Data Processing :Network Data Flow



THANKS