[Proposed changes to 802.16n SRD]

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Base Contribution:

None

Purpose:

For discussion in TGn and adoption in the SRD.

Notice:

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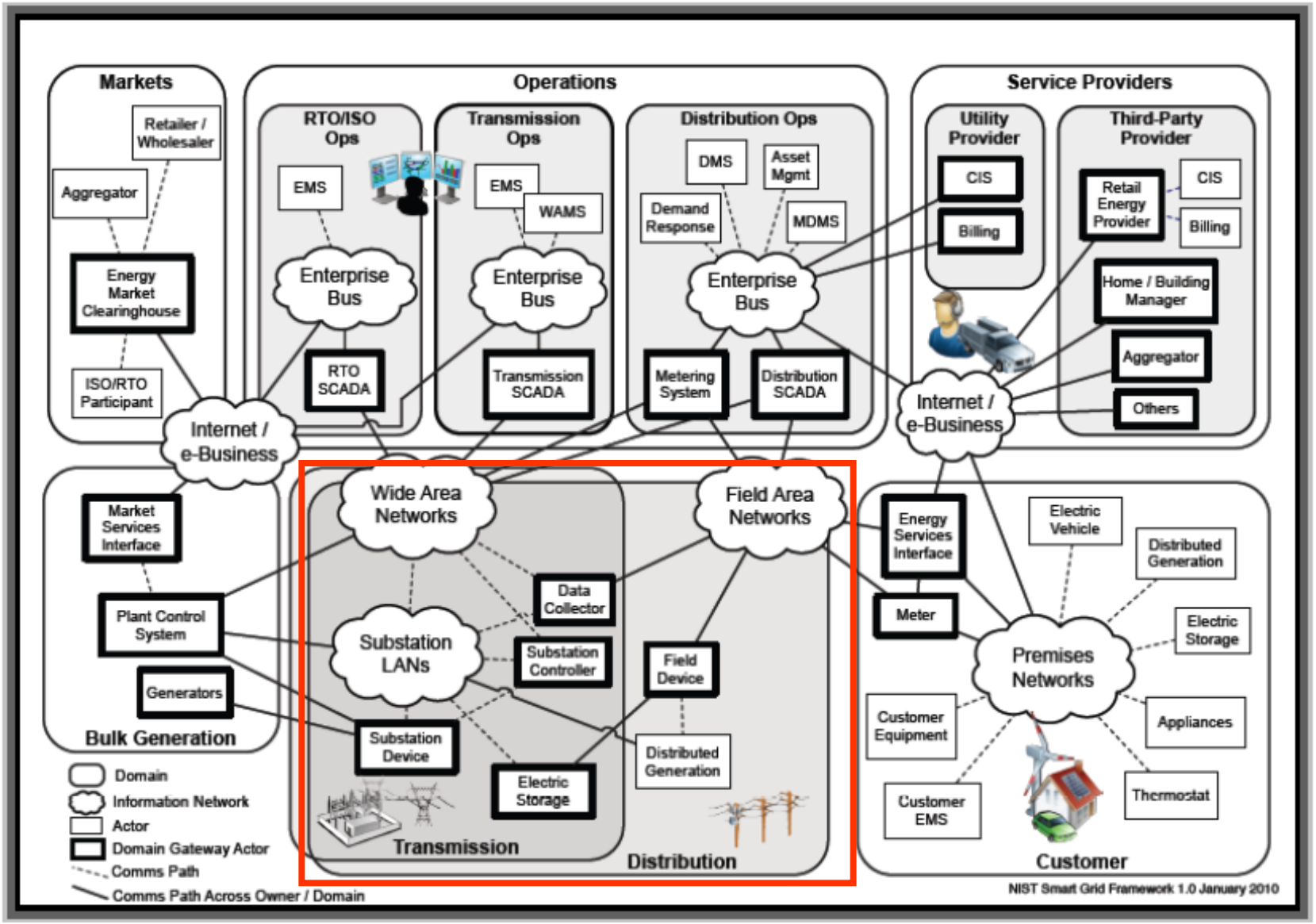
Patent Policy:

Higher Reliability in Smart Grid: a 16n Goal

- In the 16n PAR and 5C document, the "Needs for this project" states:
  - Communications technologies supporting Smart Grid applications such as monitoring and control of generation, transmission, distribution and consumption of energy resources.
  - Support communication with **higher reliability** that may be used in some Smart Grid applications.
- This document focuses on the requirements relevant to the Smart Grid applications in 16n.

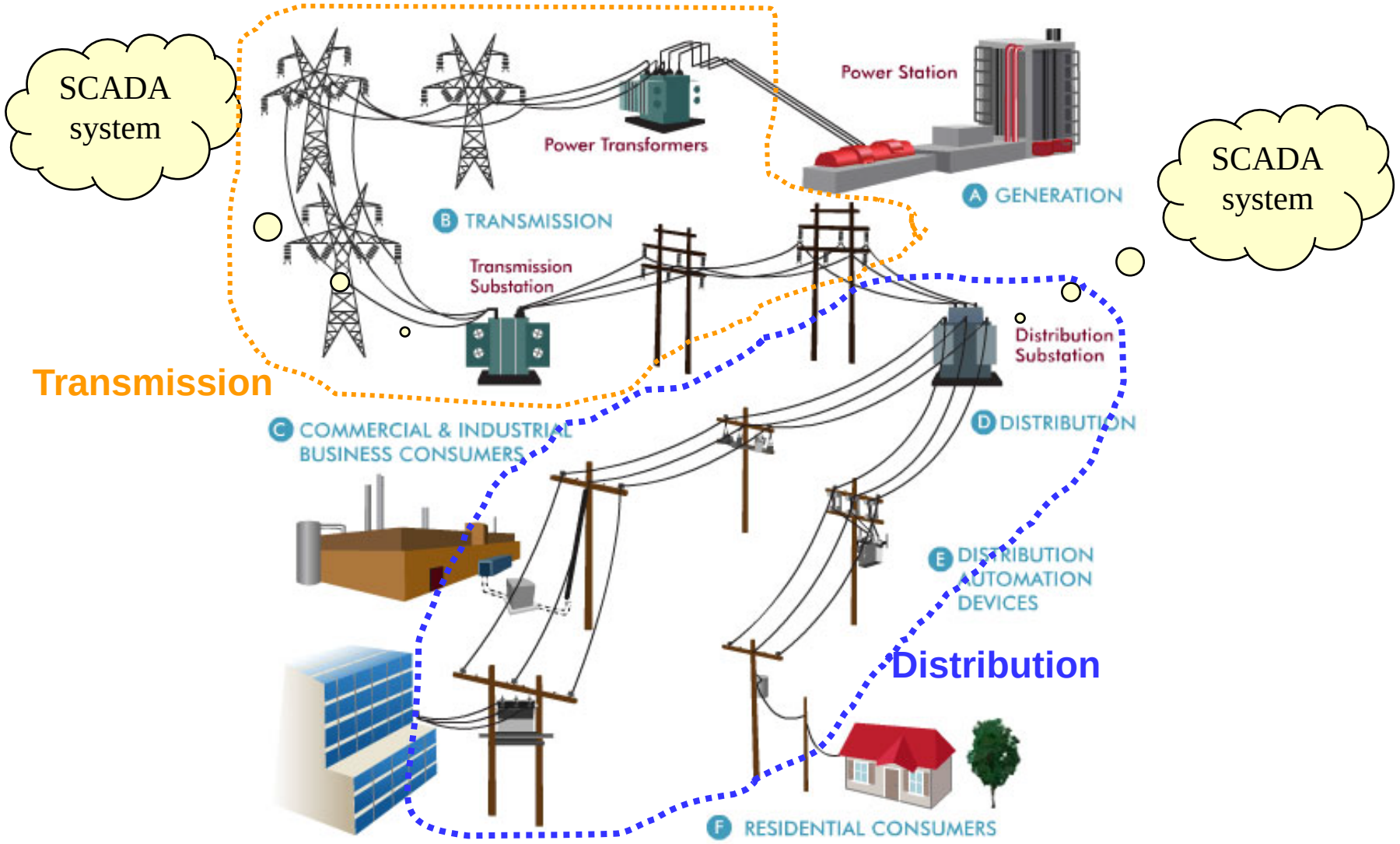
The NIST Smart Grid Reference Model



IEEE 802.16n Scope for Smart Grid

- Proposed scope
  - Transmission part
  - Distribution part
- Proposed Focal Point
  - Distribution Part
- In-scope Networking Technologies
  - Wide Area Network (WAN)
  - Field Area Network (FAN)
- Goal for 16n
  - Improving Link Reliability

Power Generation/Delivery Chain



Source: Pathway to Power, http://www.oncor.com

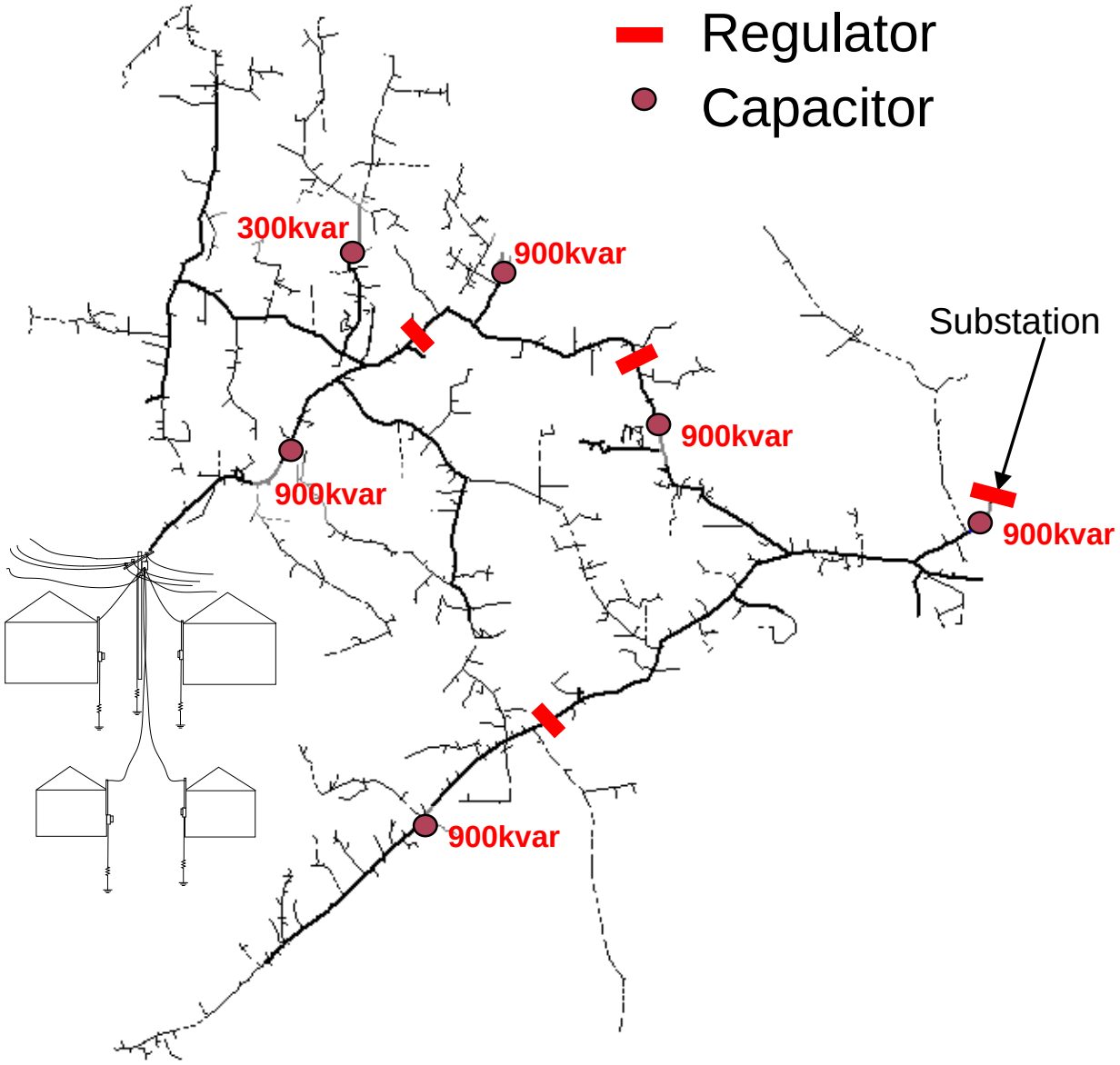
Functional Requirements in "Transmission"

- Real-time network analysis and control
  - Evaluate power system behavior in real-time
  - Changing transformer taps to regulate system voltage
  - Load balancing of feeders and transmission lines to reduce system wear and resistive losses
  - Switching capacitor banks or shunts in and out of the system to control voltage and reactive load
- Protection and stability
  - Interlocking of controls to prevent unsafe operation
  - Monitor to ensure safe operation
- Operation through faults
  - Fast recovery from emergency to normal state
  - Restoring service quickly in the event of a fault, with or without operator confirmation

Background on the “Distribution” part

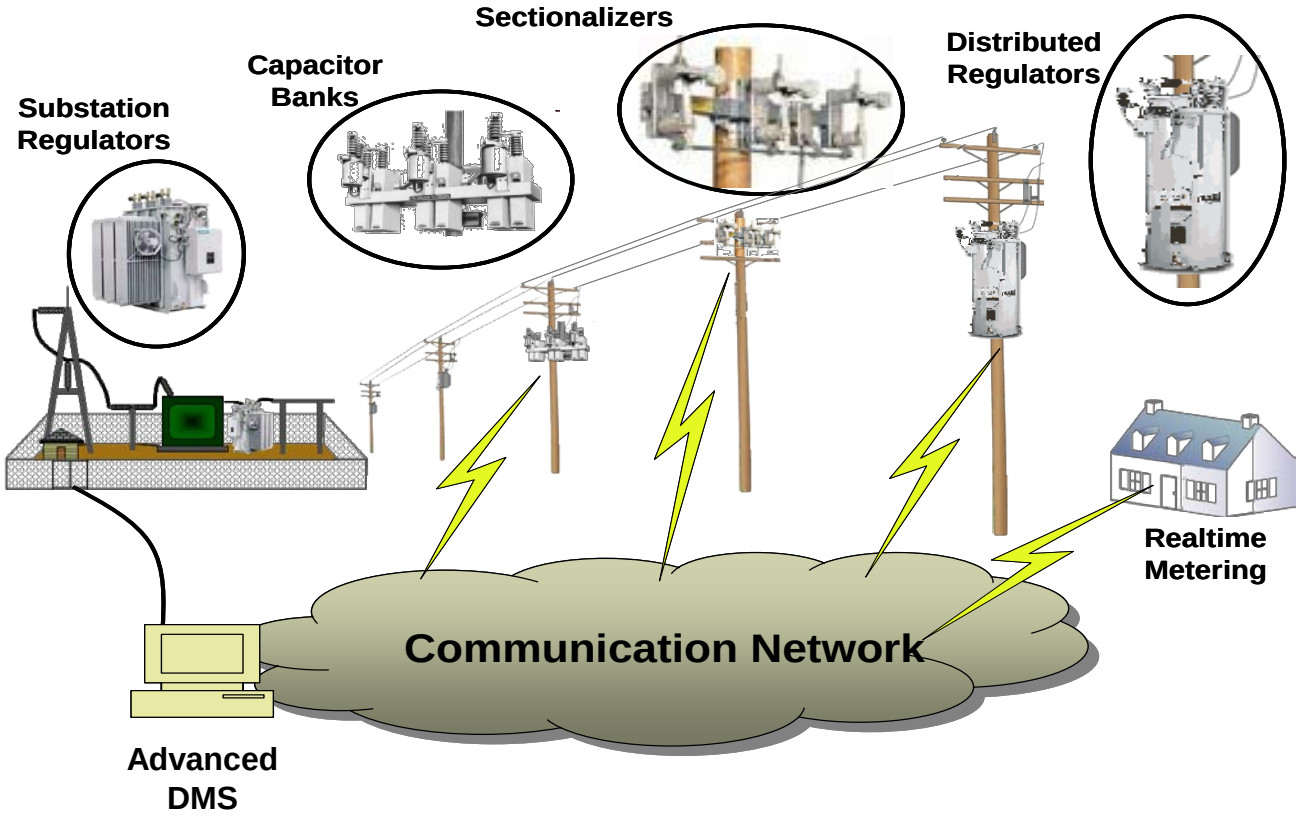
- The distribution system reaches out in all directions, called feeders. These feeders bring electricity to all who live within the electric utility’s service area.
- The network architecture for a distribution network system is either a radial or interconnected design.
- Distribution networks are a mix of overhead line construction utilizing traditional utility poles and wires, underground construction with cables and indoor or cabinet substations.

Distribution System Modeling



Source: Some High-Level, Smart Grid Requirements", WFA Wi-Fi Alliance Meeting, Paris, France, Feb 23-25, 2010

Field Area Communication in the distribution part



Source: Some High-Level, Smart Grid Requirements", WFA Wi-Fi Alliance Meeting, Paris, France, Feb 23-25, 2010

Functional Requirements in "Distribution"

- Distribution Automation
  - Power quality measurement and notifications.
  - Communication and information exchanges to monitor conditions at different locations
  - Self-healing grid function
- Data Acquisition and Control
  - Data from the power system to systems and applications that use the data.
  - Issuing of control commands to devices, equipments and other field systems.
- Integration of Distributed Energy Resources
  - Renewable energy sources would need to be integrated in the future.

Field Area Network Requirements from Utility Co's

- Reliability: ability to maintain operation during disruptions
  - Southern Company requires 5 "9s" of reliability (six minutes outage per year)
  - Cellular offers 2 "9s" of reliability (3.5 days per year)
- Potential Mechanism for increasing reliability
  - Introduce path redundancy
    - E.g. relaying between base stations

General Requirements (1/3)

- Distribution part
  - Provide path redundancy for the following communications:
    - Metering devices to Field device (regulator, sectionalizer, capacitor bank)
    - Field device to Field device
    - Field device to substation
    - Field device to distributed resources (energy storage, combustion turbine, wind/solar power)
    - Distributed resource to Distributed resource
    - Distributed resource to distribution substation
  - Re-routing when path failure happens

General Requirements (2/3)

- Substation to SCADA system
  - High throughput
    - required to support collected data and control signaling from many distribution devices and substations
  - Communication path redundancy
    - required to combat single point failure

General Requirements (3/3)

- Monitoring and sensing
  - Monitoring all environment factors (temperature, sound, vibration, pressure) at transmission and distribution units to prevent unit failure
  - Monitoring wind, weather and tide for renewable energy resource control

Performance Requirements

- Peak spectral efficiency
- Link Throughput
- Latency
- QoS
- Security
- Cell coverage
- Mobility
- Fault detection time
- Fault healing/isolation time
- Failure detection time
- Recovery/Self-healing time from failure
- Restoration time
- Path routing time

Functional Requirements

- Communication configuration
  - Support interaction between a few clients (substations) and many servers.
  - Support interaction between few servers (substations) and many clients (field devices).
  - ...
- QoS
  - Messaging latency (4ms to few 10s of seconds)
  - High frequency of data exchanges
  - ...
- Security
  - Authorization service for access control.
  - Information integrity.
  - ...
- Data Management
  - Large volumes of data flows
  - Keeping data consistent and synchronized
  - ...

Proposed text changes to 16n SRD

- After discussion and review, include
  - General requirements into section 5
  - Functional requirement into section 6
  - Performance requirement into section 7