PROTECTION ENGINEERS GROUP

HUNTSVILLE, AL - MARCH 13-15, 2018

5G Protection Considerations

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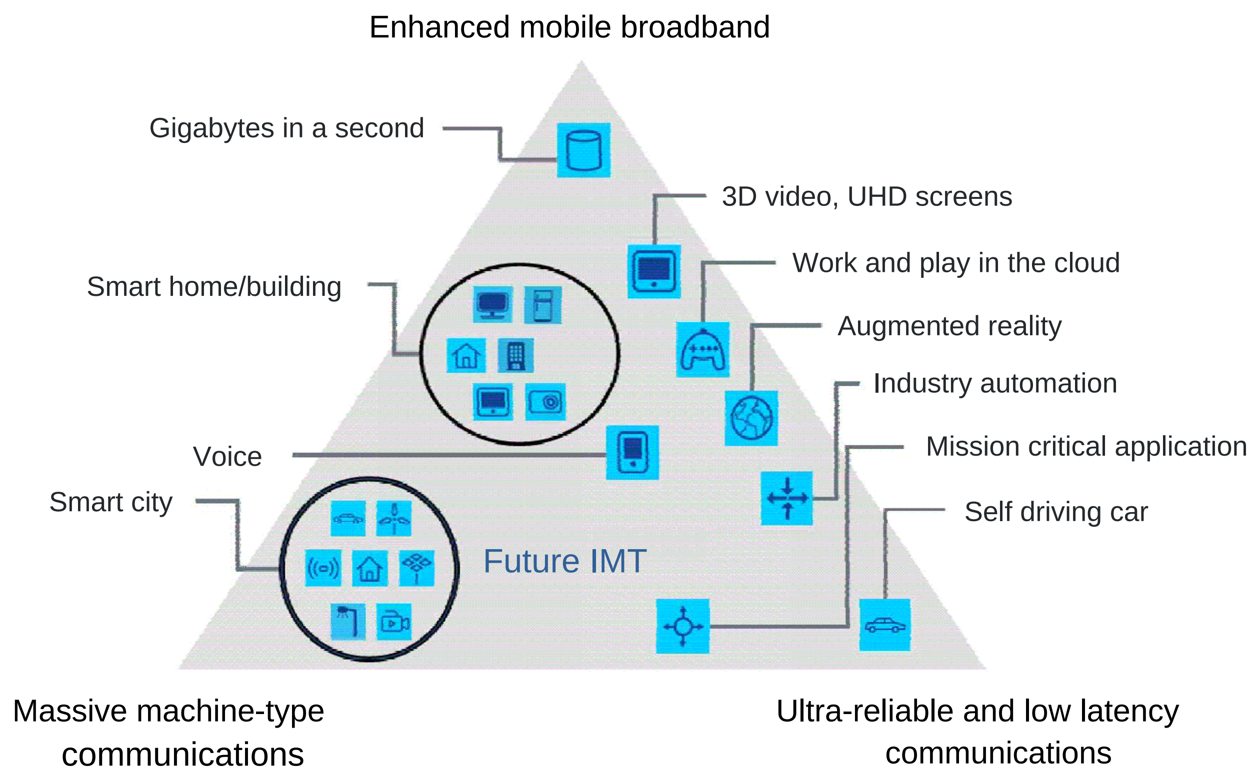
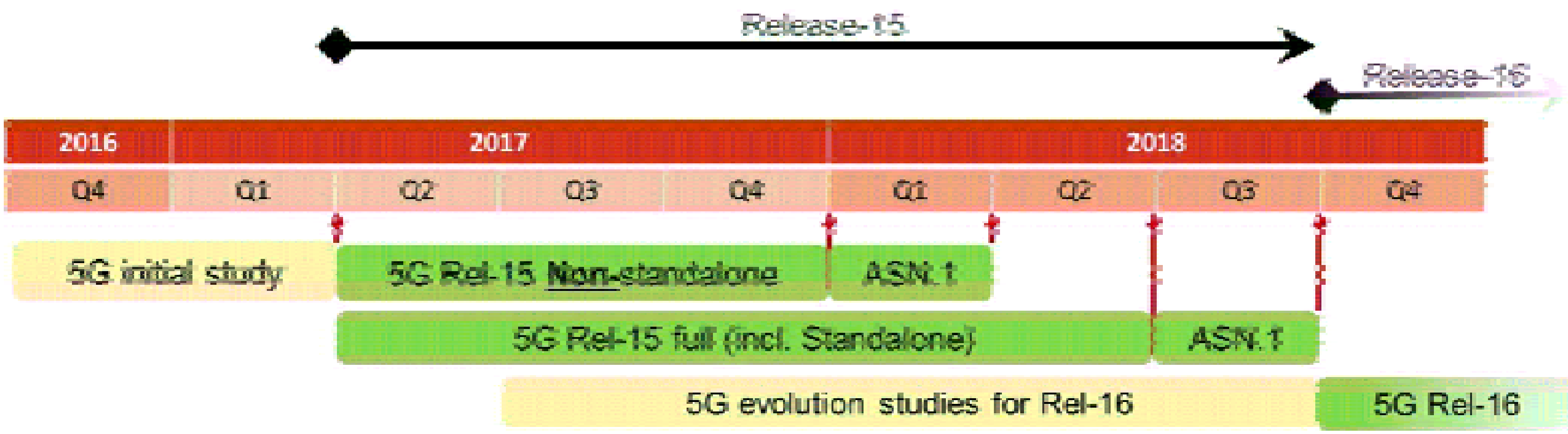
ict-surge-protection-essays.co.uk

Usage scenarios of International Mobile Telecommunications (IMT) for 2020 and beyond with 5G as the enabler



Recommendation ITU-R M.2083-0 (09/2015)
IMT Vision — Framework and overall objectives of the future development of IMT for 2020 and beyond

3rd Generation Partnership Project (3GPP) standards supporting IMT 2020 5G



[Source: 3GPP RAN Plenary #75-77 (B.Balasz presentation)

Abstract Syntax Notation One (ASN.1) is a standardized notation used for describing the structure of data carried by messages exchanged between communicating entities.

Source: Assessment of energy efficiency of 5G by Mauro BOLDI
https://docbox.etsi.org/Workshop/2017/20171123_ITU_ETSI_ENV_REQ_5G/S01_PART1/5G_EE_ASSESSMENT_ETSIEE_ITUTSG5_BOLDI.pdf

5G design features

- Higher data rates
- Lower latency
- Provides IoT and the related low data rate services
- Carrier aggregation and multiple connectivity
- Massive MIMO (multiple-input and multiple-output) antenna systems
- Multilevel sleep modes
- Includes hooks to help cloudification and virtualisation
- Network slicing for different applications
- Energy consumption of IMT-2020 network not be greater than current IMT networks

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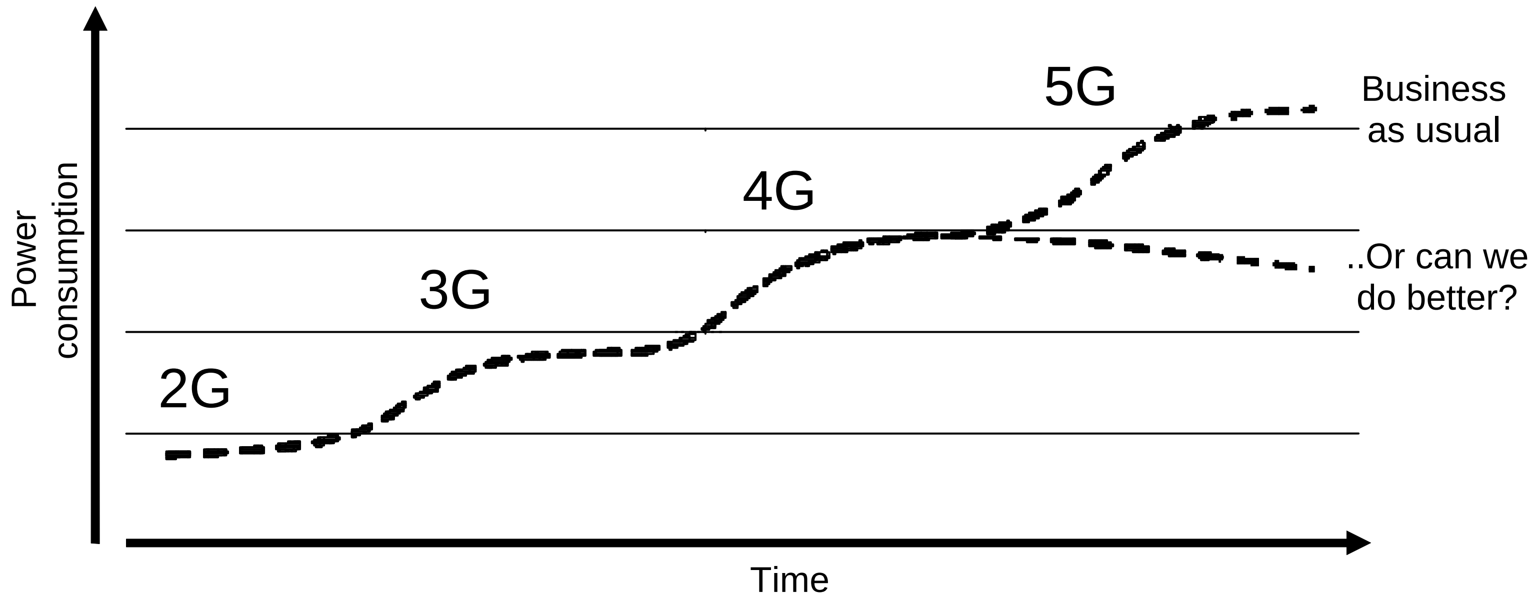
https://docbox.etsi.org/Workshop/2017/20171123_ITU_ETSI_ENV_REQ_5G/S01_PART1/5G_EE_ASSESSMENT_ETSIEE_ITUTSG5_BOLDI.pdf

5G energy efficiency and power consumption — 1

- 80 % of the radio access network (RAN) power is taken by macrobase stations, where the major power consumer is the radio power amplifier.

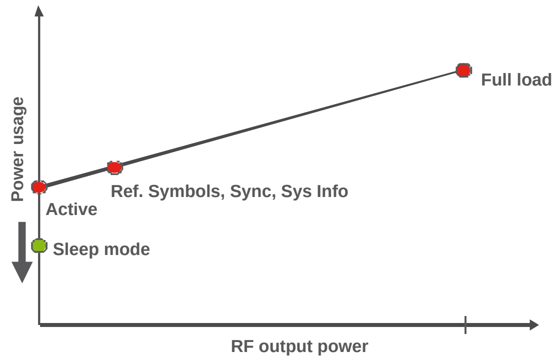


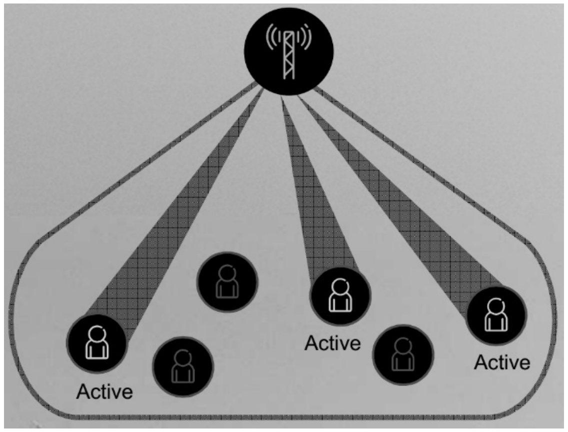
Source: 5G Network Energy performance by Dr. Pål Frenger,
https://docbox.etsi.org/Workshop/2017/20171123_ITU_ETSI_ENV_REQ_5G/S01_PART1/5G_NWK_ENER_PERF_ERICSSON_FRENGER.pdf

5G energy efficiency and power consumption — 2

Low energy consumption design concepts

- Only be active and transmit when needed
  - Separation of active and idle (sleep) mode functions
  - Large sleep ratio and long sleep duration
  - Load adaptive energy consumption
- Only be active and transmit where needed
  - High Gain Massive MIMO Beamforming
  - Targeted customers increases range and reduces the number of base stations





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5G frequencies

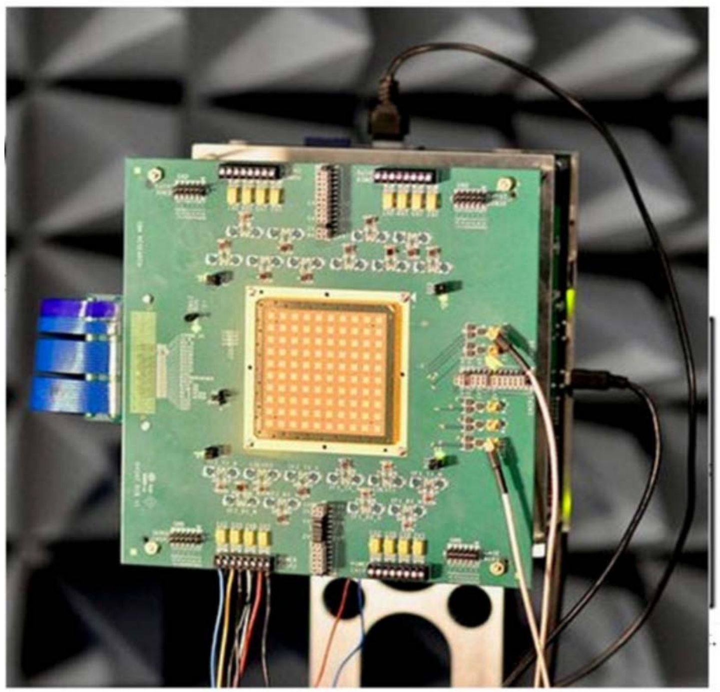
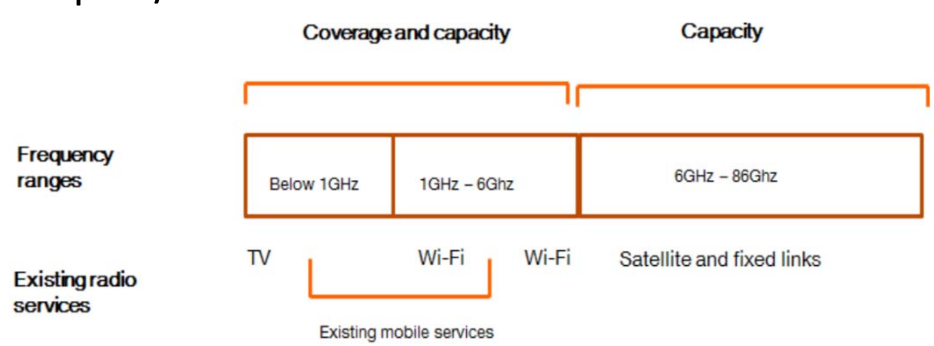


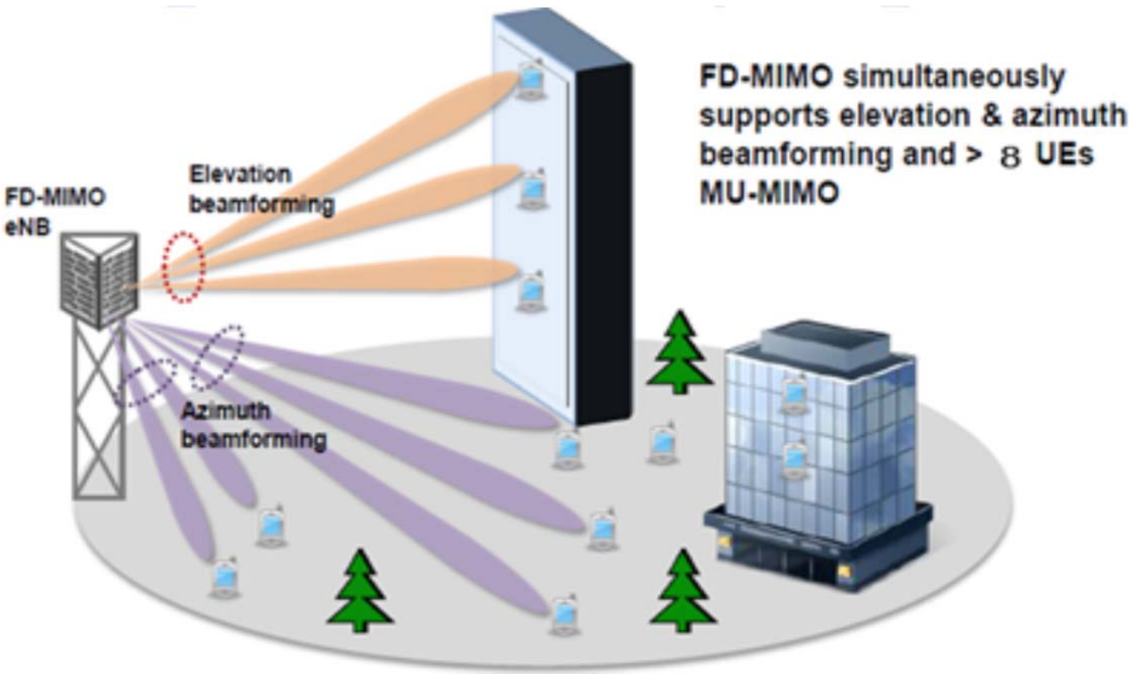
Fig. 5. 8 × 8 5G millimeter-wave array made by IBM and Erickson [17].

- Smart antennas, that are planned for use in 5G will have narrow antenna beam (or beams) directed directly to the user (or users)
- 5G NR radio access network will combine all types of cells: macro, micro, small and pico/femto.



Source: Impact of 5G technology on human exposure by Dr. Fryderyk Lewicki, https://docbox.etsi.org/Workshop/2017/20171123_ITU_ETSI_ENV_REQ_5G/S02/5G_TECH_IMPACT_HUMAN_EXPOS_LEWICKI_ITUTSG5.pdf

5G MIMO



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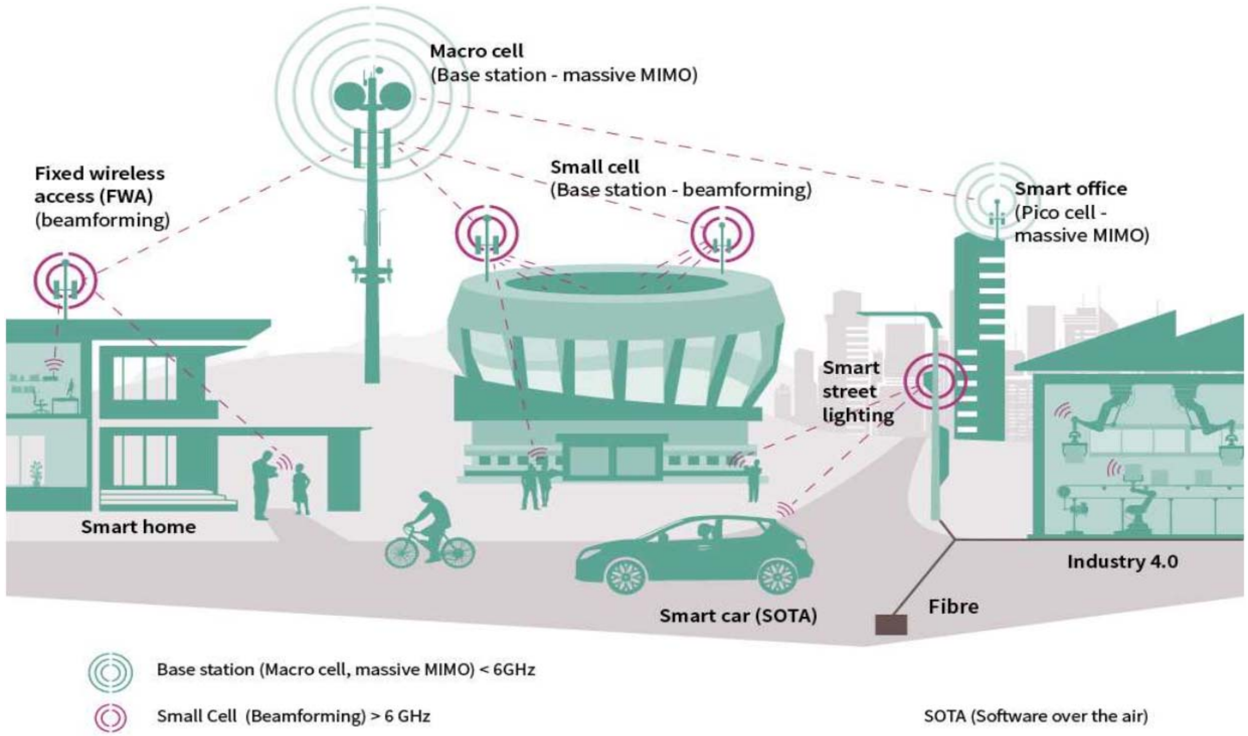
5G deployment — 1

Source: Sustainable green 5G powering by Didier Marquet,
https://docbox.etsi.org/Workshop/2017/20171123_ITU_ETSI_ENV_REQ_5G/S01_PART1/POWERING_5G_ETSIEE_ITUTSG5_MARQUET.pdf

5G deployment — 2 (Macro to Femto/Pico cells)



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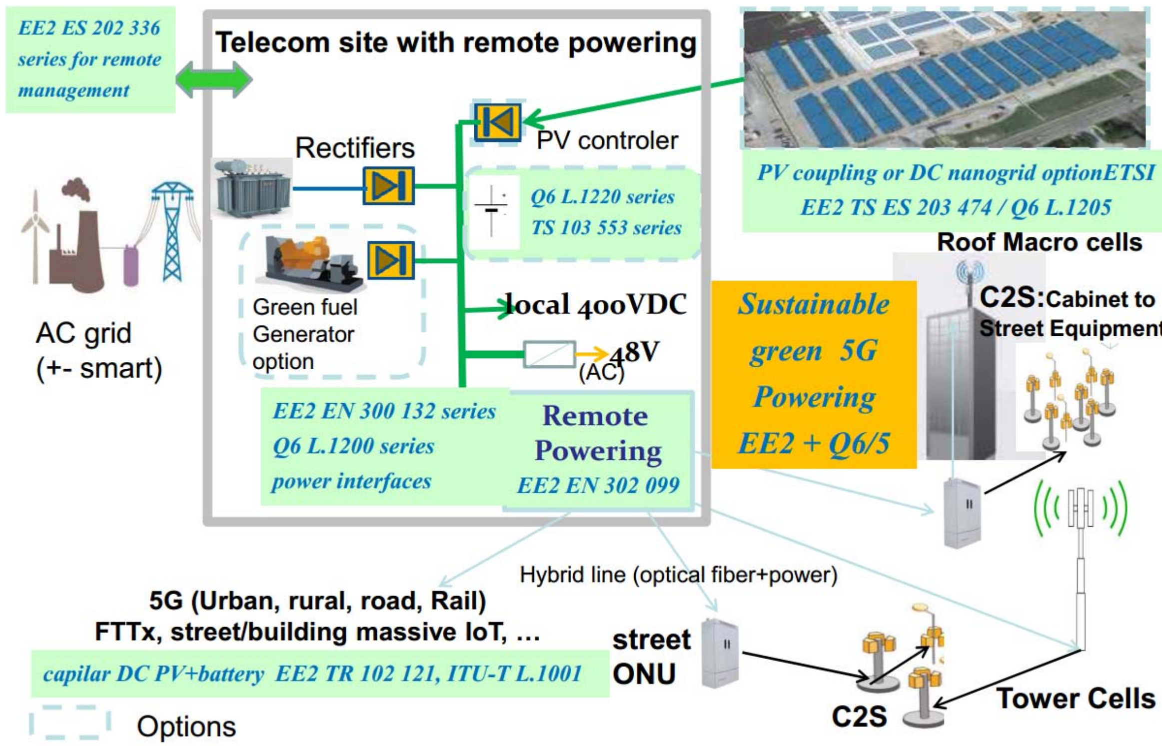
5G powering



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ITU-T Recommendations on powering

- L.1001: External universal power adapter solutions for stationary information and communication technology devices
- L.1200: Direct current power feeding interface up to 400 V at the input to telecommunication and ICT equipment
- L.1201: Architecture of power feeding systems of up to 400 VDC
- L.1202: Methodologies for evaluating the performance of an up to 400 VDC power feeding system and its environmental impact
- L.1203: Colour and marking identification of up to 400 VDC power distribution for information and communication technology systems
- L.1204: Extended architecture of power feeding systems of up to 400 VDC
- L.1205: Interfacing of renewable energy or distributed power sources to up to 400 VDC power feeding systems
- L.1206: Impact on ICT equipment architecture of multiple AC, -48 VDC or up to 400 VDC power input

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https://docbox.etsi.org/Workshop/2017/20171123_ITU_ETSI_ENV_REQ_5G/S01_PART1/POWERING_5G_ETSIEE_ITUTSG5_MARQUET.pdf

ETSI Standards on powering

- ETSI EN 302 099 Environmental Engineering (EE); Powering of equipment in access network
- ETSI EN 300 132-2 Environmental Engineering (EE); Power supply interface at the input to telecommunications and datacom (ICT) equipment; Part 2: Operated by -48 V direct current (dc)
- ETSI EN 300 132-3-0 Environmental Engineering (EE); Power supply interface at the input to telecommunications and datacom (ICT) equipment; Part 3: Operated by rectified current source, alternating current source or direct current source up to 400 V, Sub-part 0: Overview
- ETSI EN 300 132-3-1 Environmental Engineering (EE); Power supply interface at the input to telecommunications and datacom (ICT) equipment; Part 3: Operated by rectified current source, alternating current source or direct current source up to 400 V, Sub-part 1: Direct current source up to 400 V
- ETSI TS 102 121 Environmental Engineering (EE); Power distribution to telecommunications and datacom (ICT) equipment

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5G surge protection

Data feed

– For large traffic volumes, fibre is the obvious choice and requires little electrical protection.

– More modest traffic volumes can be serviced by wireless or wired connections. Established protection techniques exist for wired data feeds

Power feed

– AC power: Typically, the miniature base station equipment is powered by AC from the power utility.

– DC power: Miniature base stations installed at an existing base station site, will typically be powered by the sites -48V DC power supply. Remote units could have powering voltages from 48 V to ±200 V or could have a local power source.

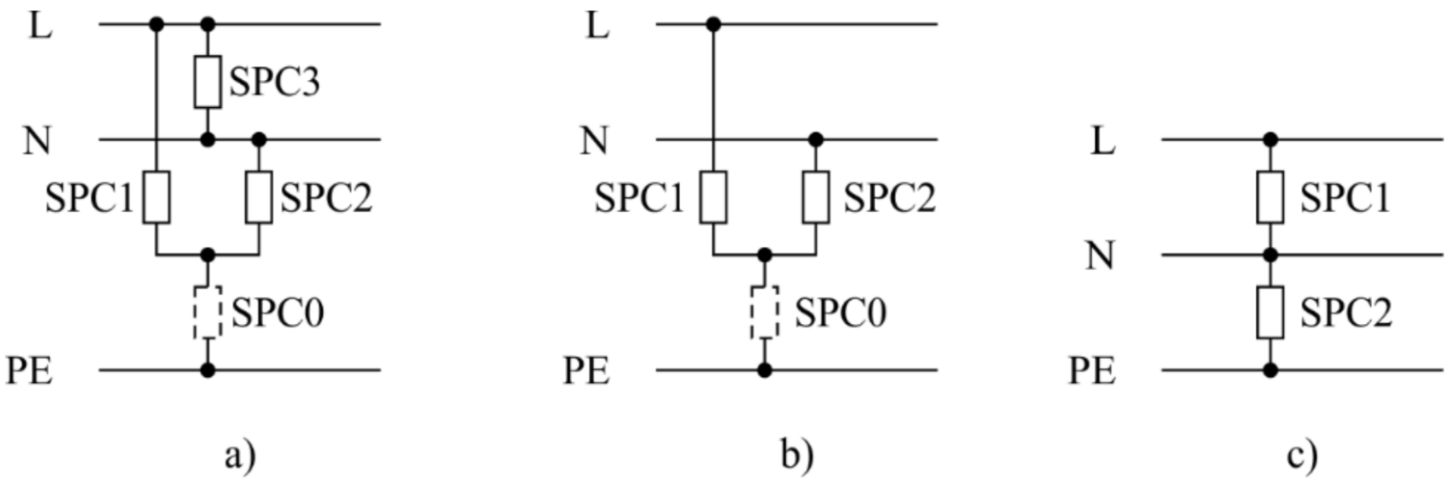
– Power over Ethernet (PoE). For those base stations with very modest requirements, PoE provides an easy and convenient way to power the equipment.

Resistibility topics in 5G networks, Mick Maytum
https://docbox.etsi.org/Workshop/2017/20171123_ITU_ETSI_ENV_REQ_5G/S02/RESISTABILITY_5G_NWK_MAYTUM_BOURNS.pdf

5G powering surge protection — 1

AC power protection

The surge current rating for SPC0 (surge protective component #0) in a) and b) and SPC2 in c) needs to be for the total common mode surge current



AC power feed protection according to ITU-T K.120

5G powering surge protection — 2

DC power protection

Some protection schemes use a power source that is re-entrant or shuts down when overloads occur for a fixed time or the overload time. This allows the recovery of switching surge protection components (SPCs) that need a limited source current to switch off.
To function during the event outage, the base station can use a diode bridge and have a backup power source from such things as a battery or capacitor.

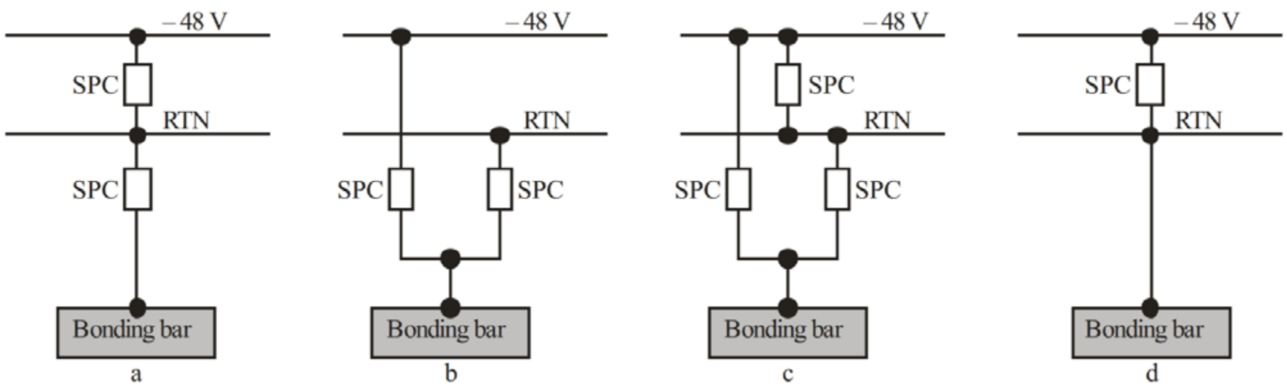
In mission critical applications the powering continuity is important and an "minimal disruption" design needs to be considered.

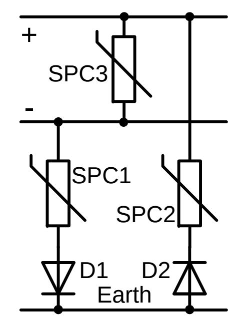
- Use of clamping SPCs for protection would avoid switching discharges.
- To effectively protect against supply overvoltages an SPC should be directly connected between the supply feed conductors.
- SPCs from the powering feed to ground/earth need to be applied carefully as discussed next.

5G powering surge protection — 2

DC power protection

- Arrangements b) and c) can equally voltage limit of the power feed conductors under common-mode surge conditions, if the supply current limits.
- Arrangement a) would prevent this for negative common-mode surges but positive surges could reverse the feed voltage.
- If the polarity of the feed conductors can be guaranteed, arrangement e) maintains a constant powering voltage during common-mode surges of either polarity by using a series diode with each of the ground/earth connected SPCs.





e)

DC power feed protection according to ITU-T K.97 (a to d)

Diode steering

ITU-T Base Station Protection Recommendations

K.27: Bonding configurations and earthing inside a telecommunication building

K.97: Lightning protection of distributed base stations

K.105: Lightning protection of photovoltaic power supply systems feeding radio base stations

K.112: Lightning protection, earthing and bonding: Practical procedures for radio base stations

K.120: Lightning protection and earthing of a miniature base station

listed at https://www.itu.int/ITU-T/recommendations/index_sg.aspx?sg=5

5G Protection Considerations

This presentation has

Given an overview of the 2020 IMT vision and the proposed 5G radio access network to support it.

Key energy efficiency features are:
only be active and transmit WHEN needed
only be active and transmit WHERE needed

In mission critical applications, the powering continuity is important and "minimal disruption" protection designs need to be considered.