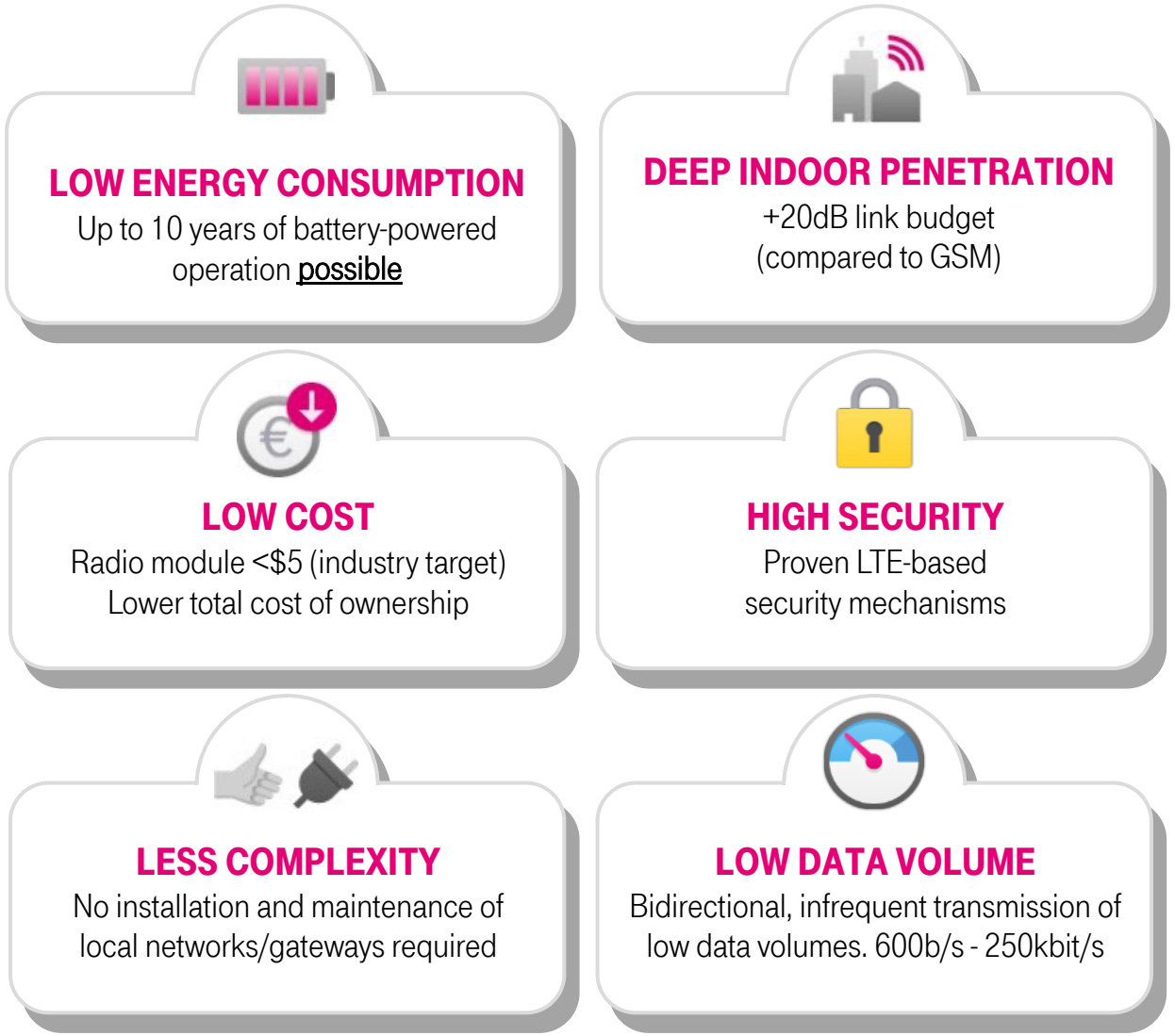
WHY NB-IOT IS SO EFFICIENT

LIFE IS FOR SHARING.

When is NB-IoT appropriate?



Customers that require:

- Deep indoor coverage
- Devices with long battery lives
- Mass-scale, affordable connectivity

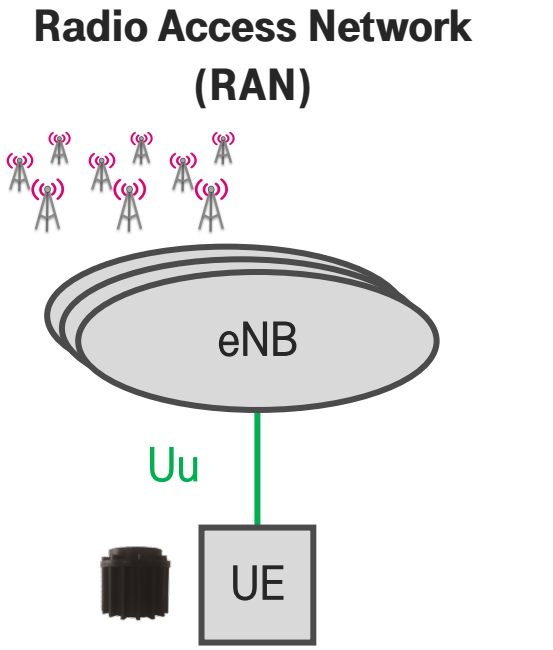
It must always pass a litmus test:

- ❑ **Infrequent messages**
- ❑ **Tolerance for high latency**
- ❑ **Losing some messages is ok**
- ❑ **No voice / SMS services used**

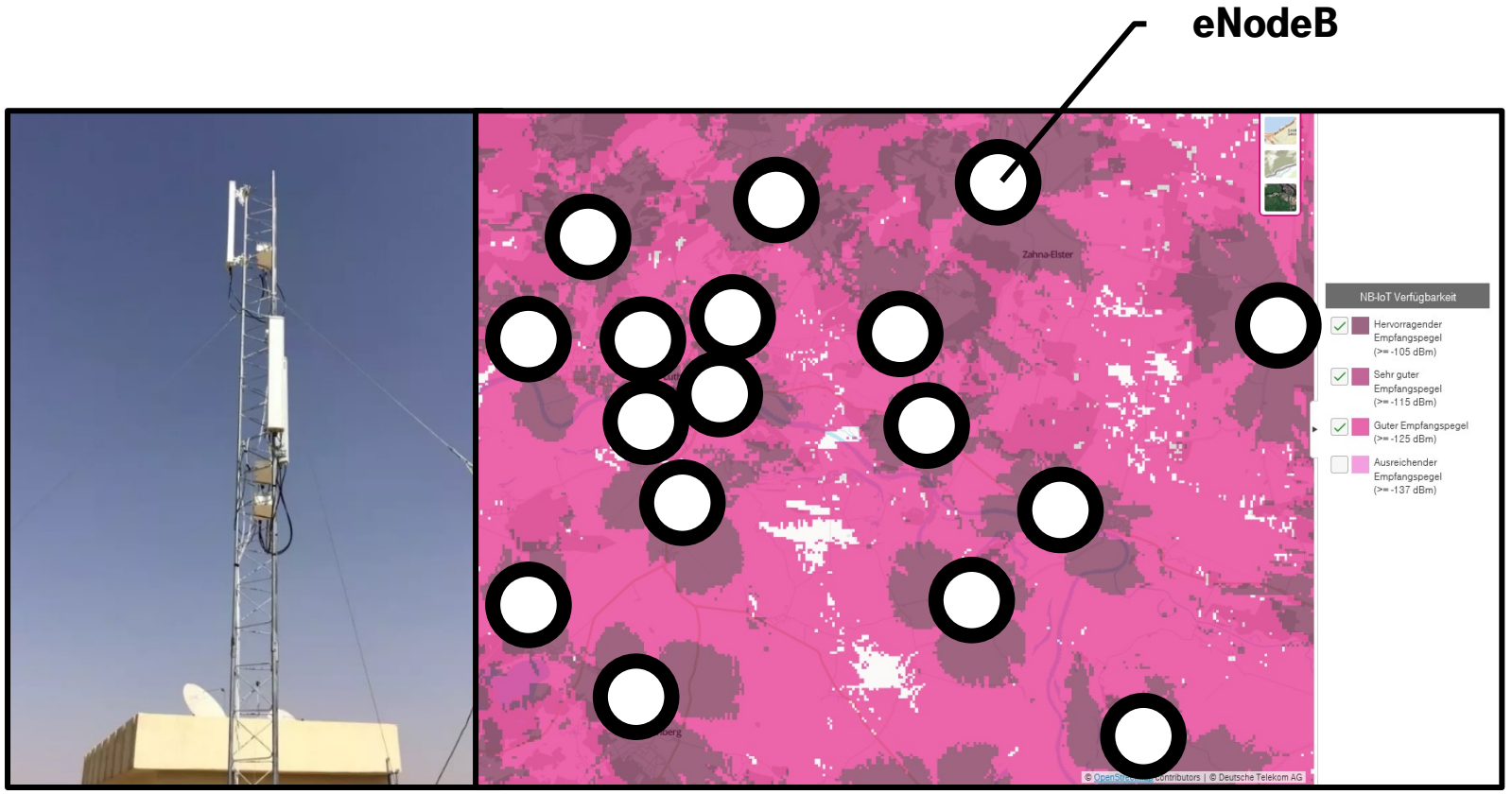
So what is the network?

LTE-M and NB-IoT network consists of a Radio Access Network (RAN) and the Core Network.

The RAN gives customers the Mobile IoT wireless Wide Area Network coverage.

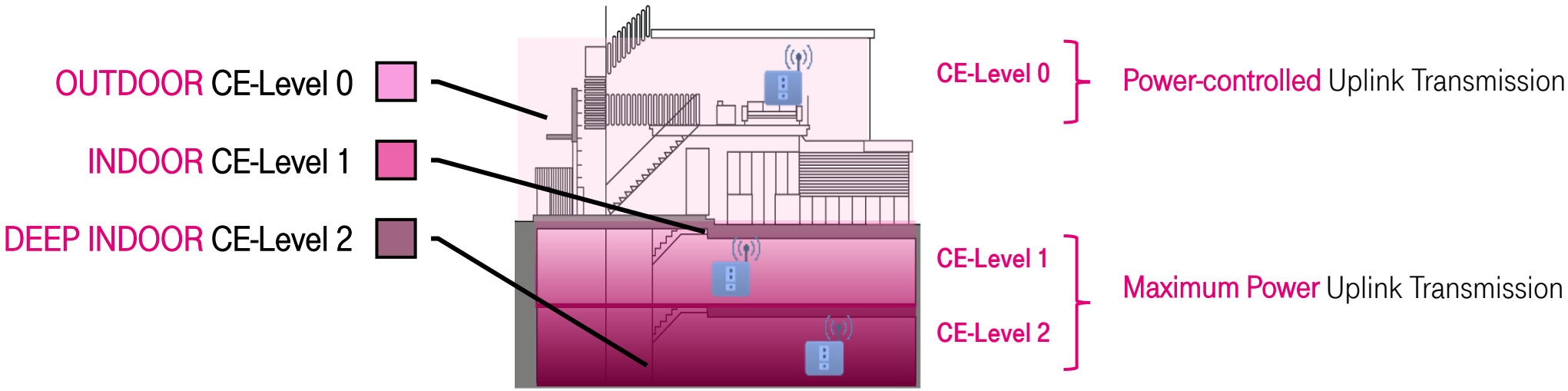


eNB: eNodeB (RAN base station)
UE: User Equipment (IoT device)



Achieving Wide Area through Coverage Enhancement (CE)-Levels

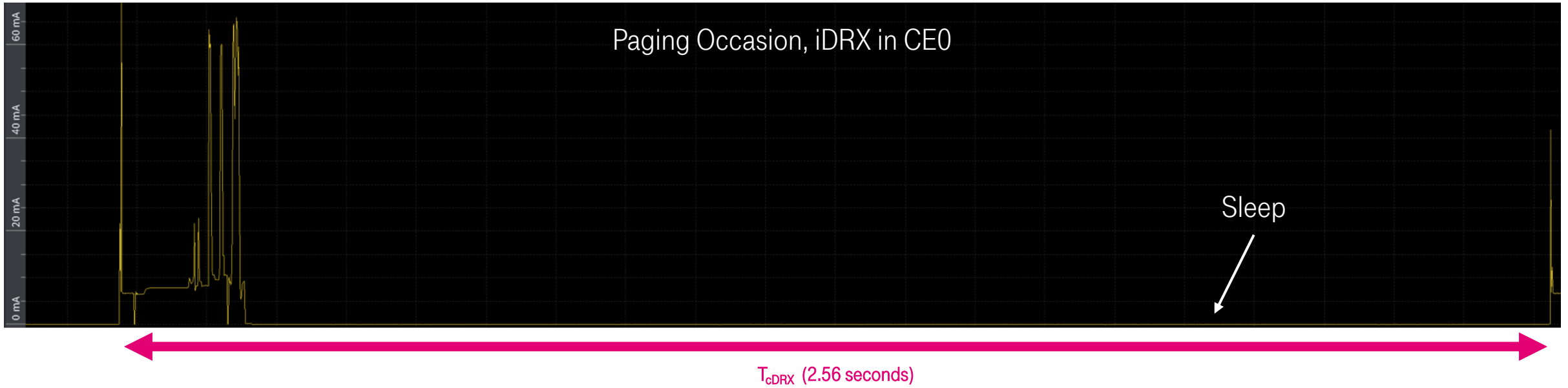
The specific CE-Level a device finds itself in has a direct impact on battery life! The coverage quality impacts the device's output power and the number of times it retransmits Uplink messages:

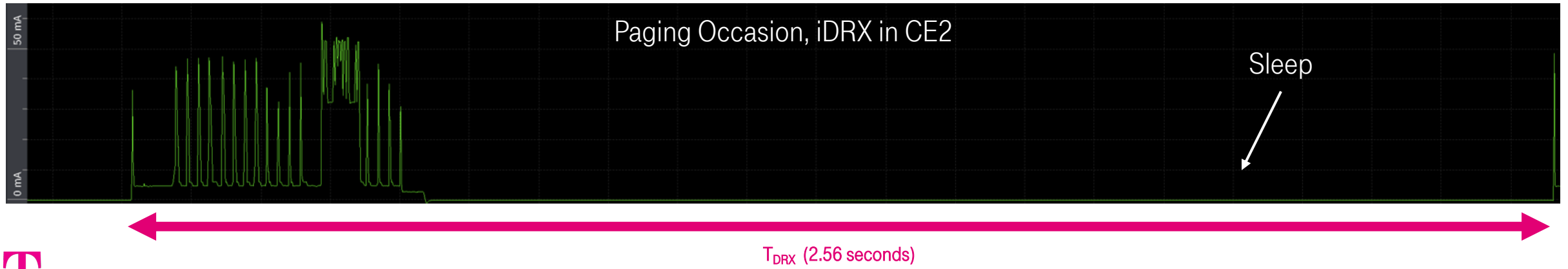


Devices in indoor and deep indoor coverage do not power control their transmissions

Example: Paging procedure in CE0 vs. CE2

Due to the message repetitions in CE2, power consumption for the same procedure in much higher as compared to CE0.



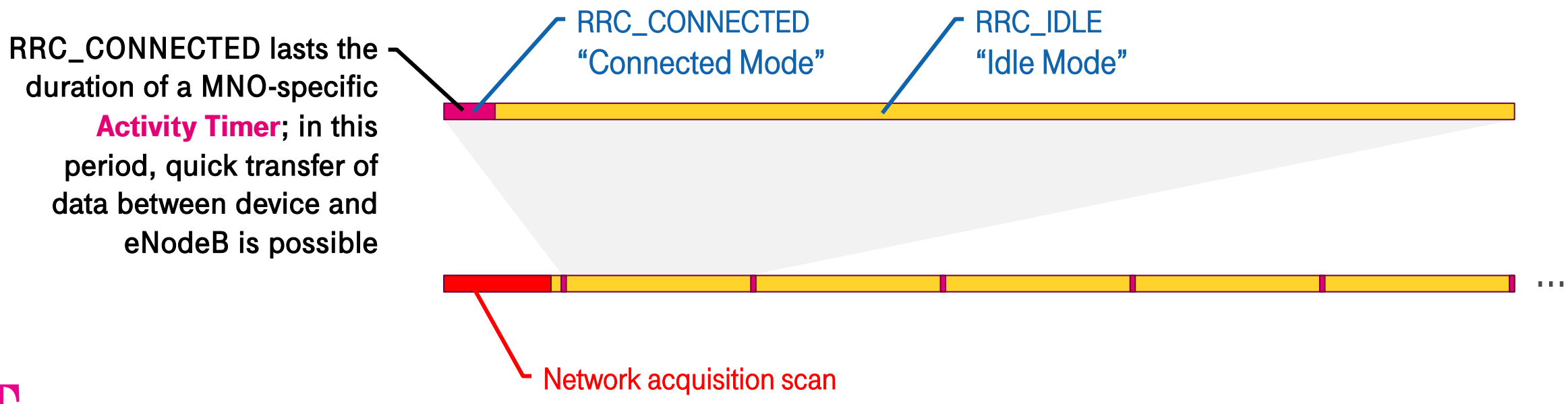


What is Connected Mode or Idle Mode?

While running, the protocol stack of the Mobile IoT device is permanently toggling between two states:

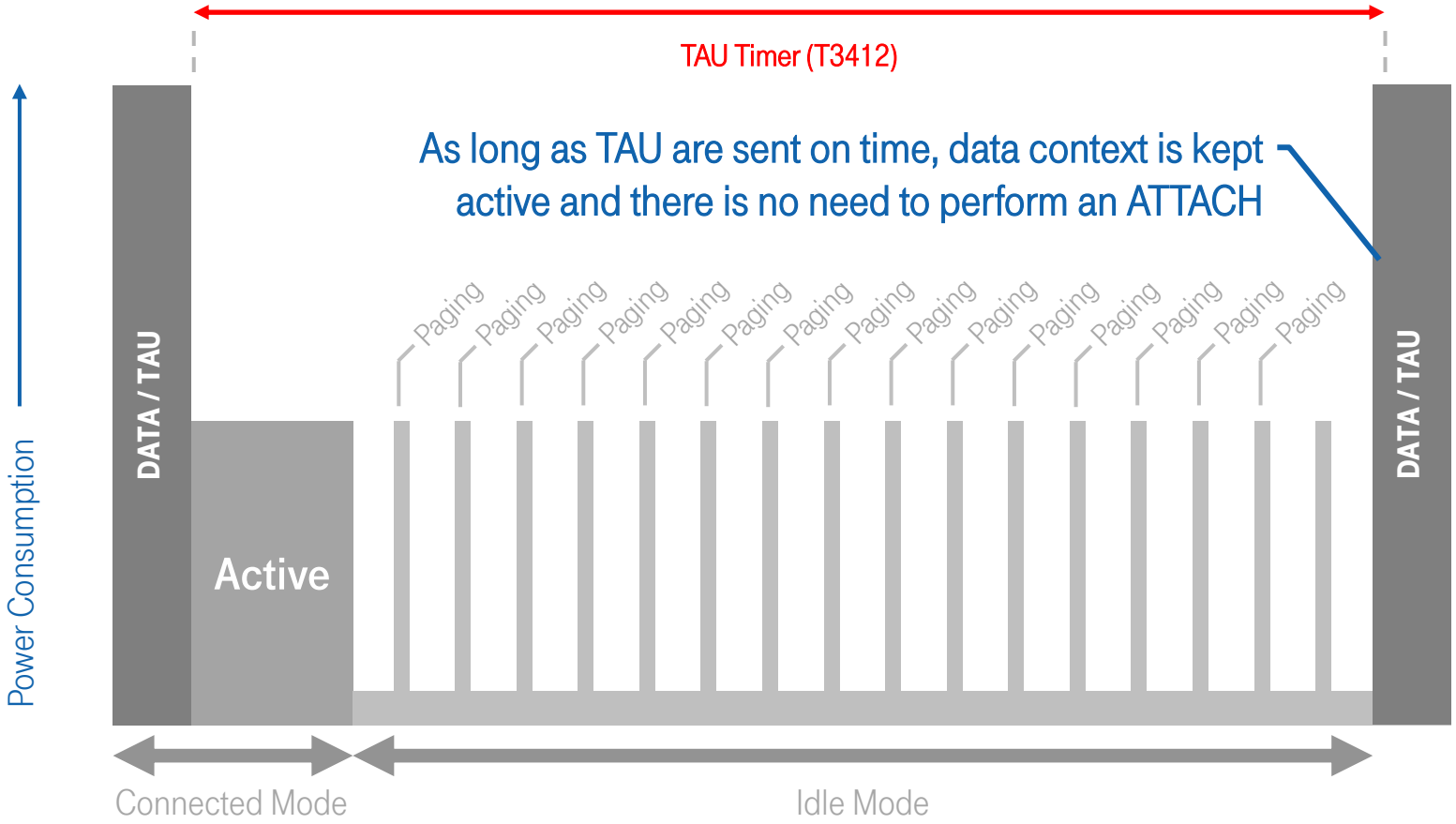
- **RRC_CONNECTED:** Radio Resource Control logical link to eNodeB is established; it is used to transfer packets over the air between the C-SGN and IoT device using the Network Access Stratum
- **RRC_IDLE:** Radio Resource Control link to eNodeB is torn-down, but Network Access Stratum session between C-SGN and IoT device remains available

Whenever the chipset is power-cycled, the device performs a prolonged network acquisition scan. For this reason, shutting down the Mobile IoT device is usually not an option for conserving battery life. 3GPP™ introduced multiple power saving feature to save the day...

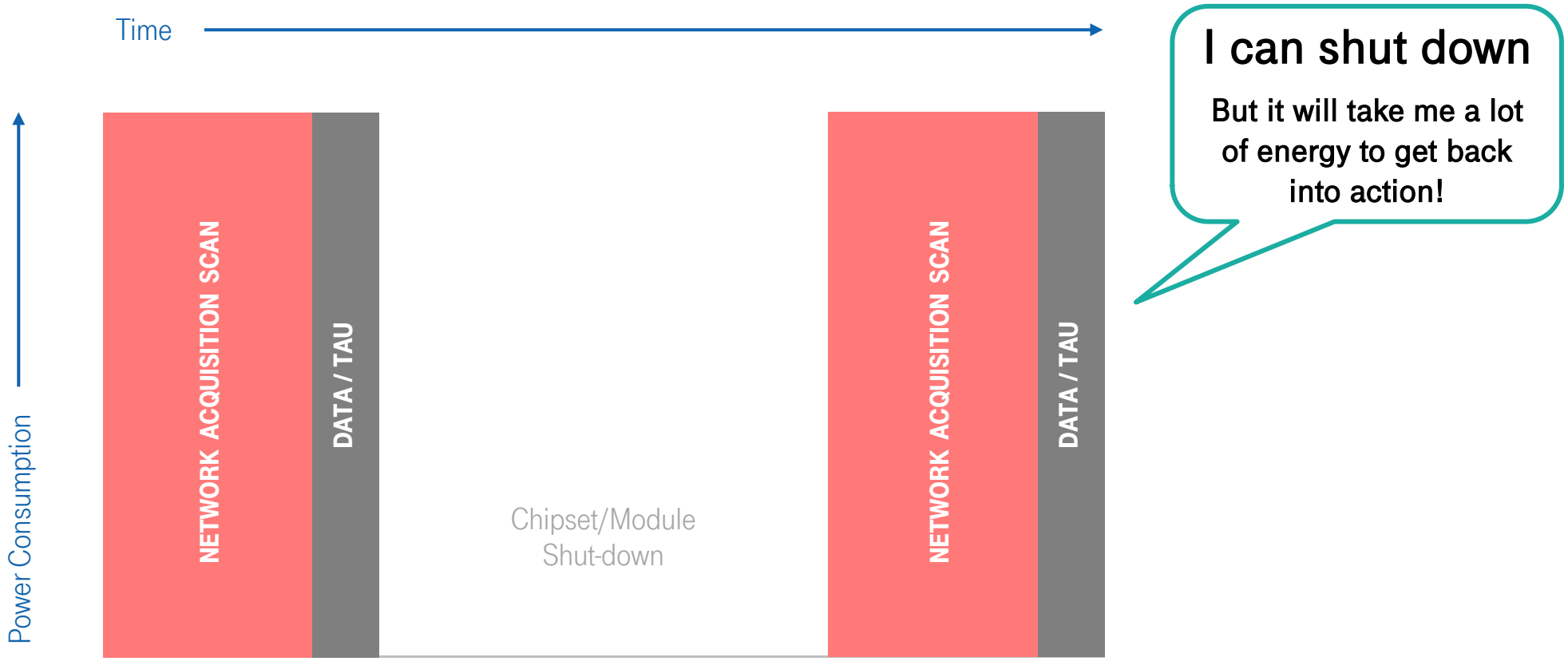


Note: The axes are not to scale.

Standard Tracking Area Update (TAU)



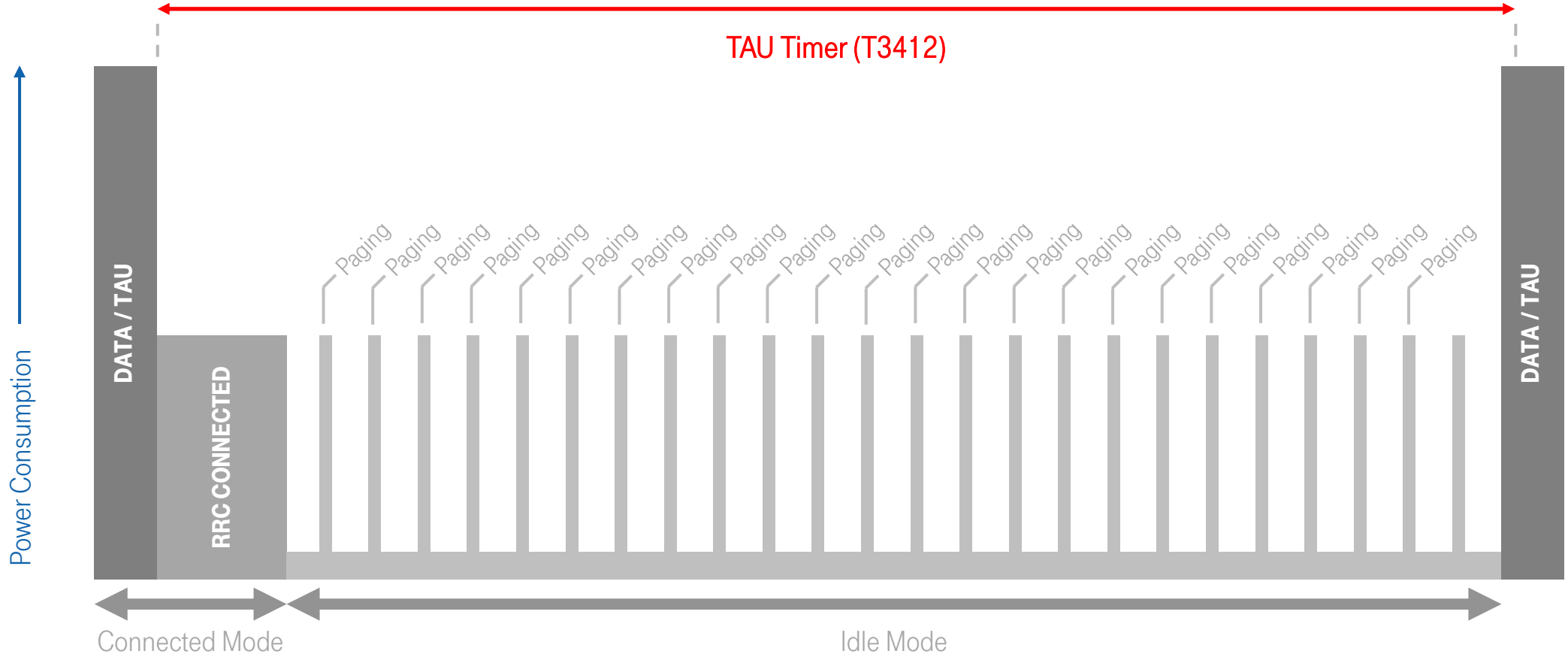
Shutting down the chipset / module



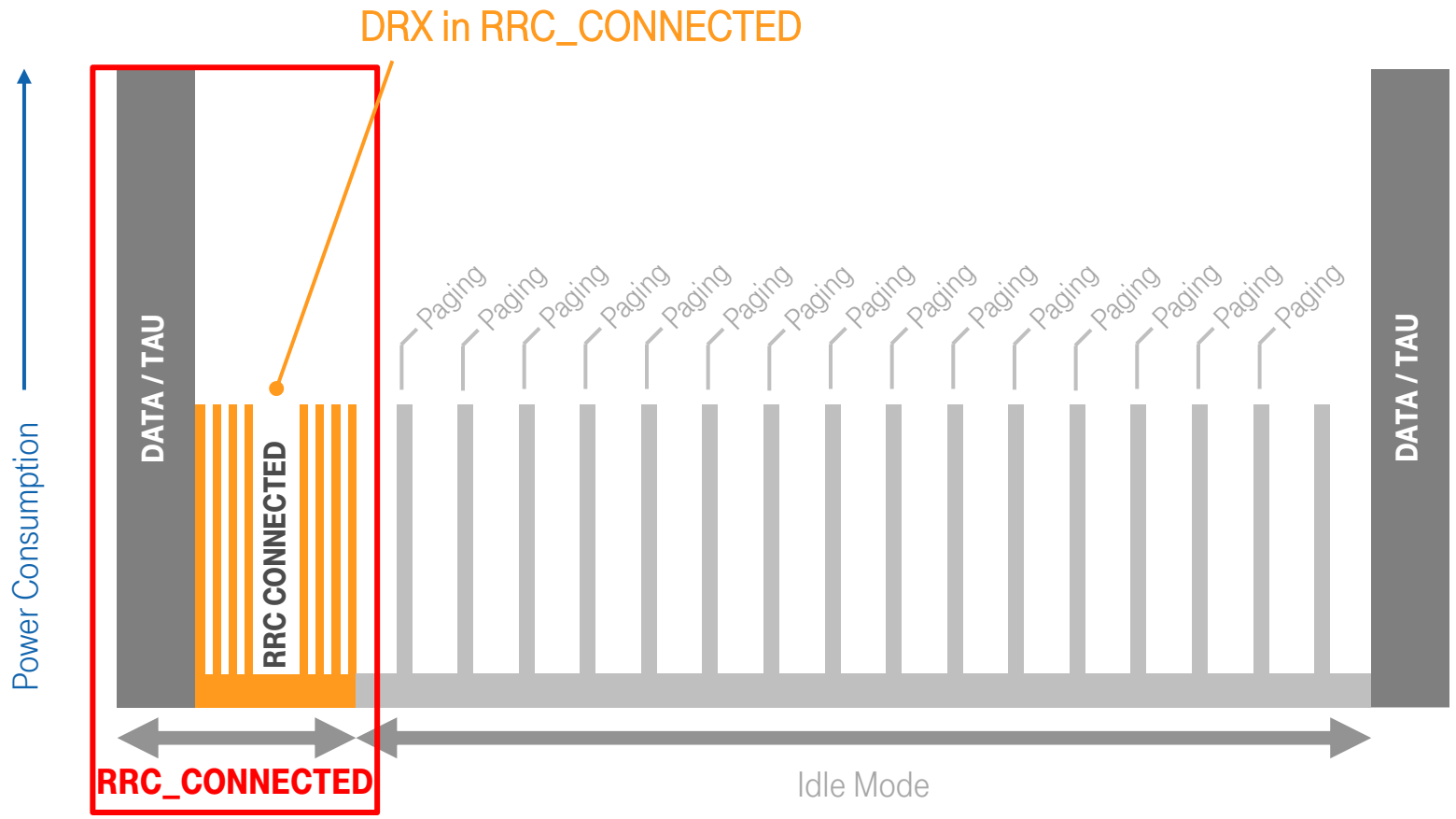
From observation, network acquisition scans of chipsets vary widely – taking from a few minutes to up to half an hour. Unless the period between messages is sufficiently long to compensate the power of such a network scan, use 3GPP™ power saving features instead.

Note: The axes are not to scale.

Long Periodic Tracking Area Update (TAU)



Connected Mode DRX (cDRX)



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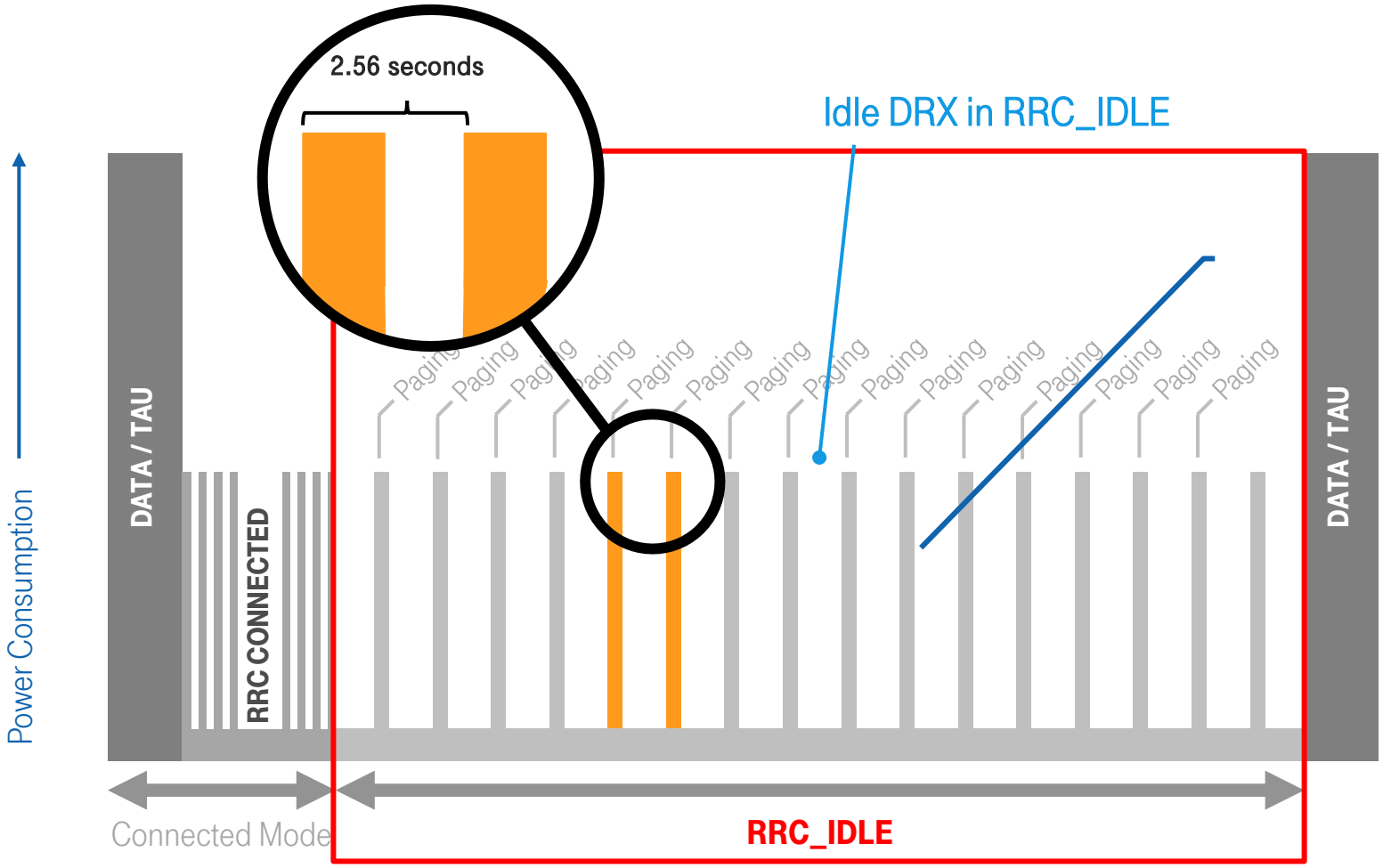
Idle Mode DRX (iDRX)



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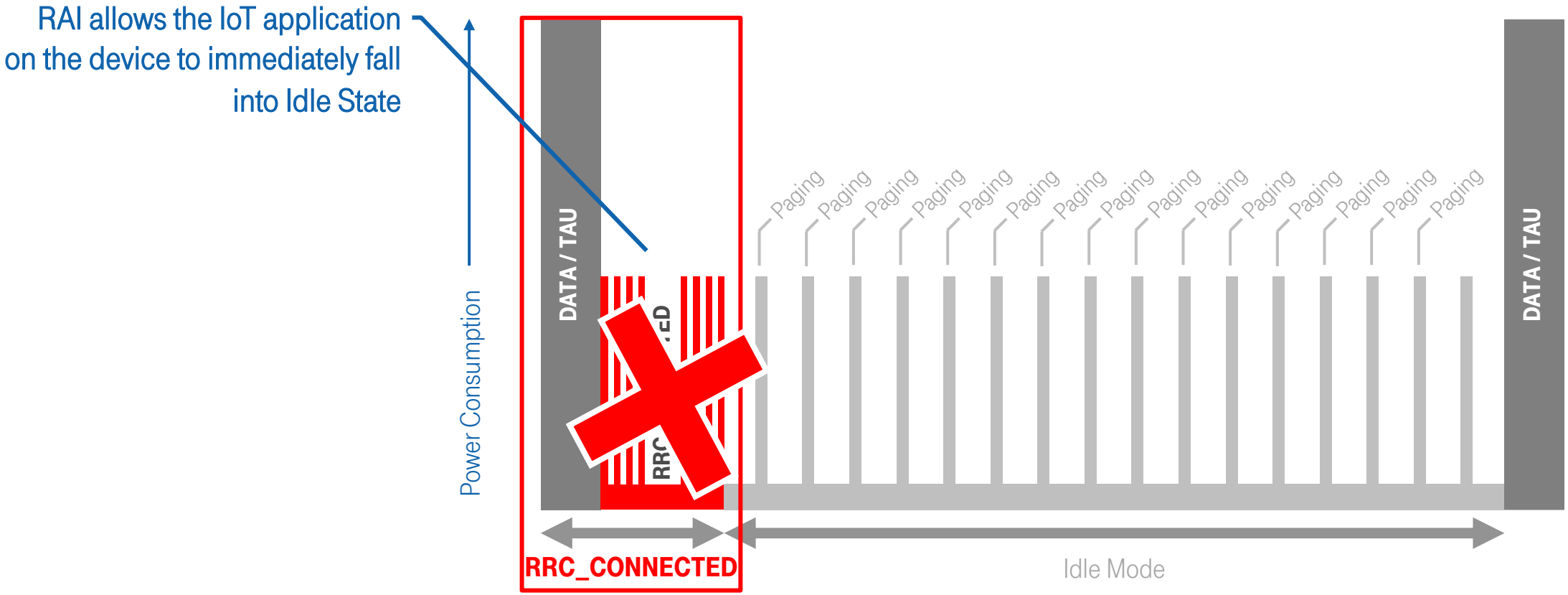
Release Assistance Indicator (RAI)

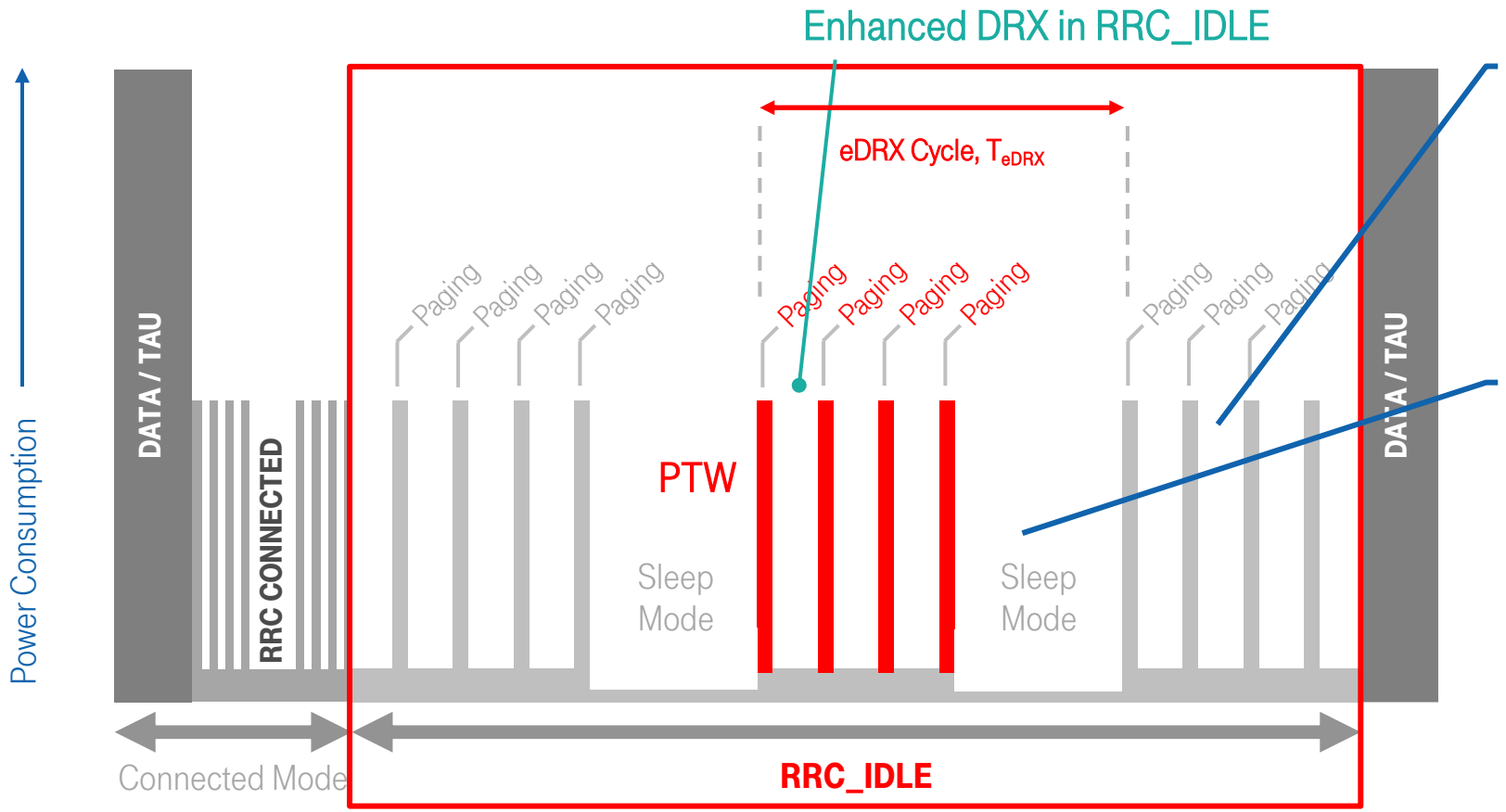
3GPP™ Rel.13 RAI allows the IoT device to prematurely tear down the RRC connection to the eNodeB. The chipset simply includes a Release Assistance Indicator IE when sending its last data package to the network. Without this feature, the IoT device is forced to remain in RRC_CONNECTED mode until the expiration of the MNO RRC Activity Timer, which is typically 20-30 seconds



Note: The axes are not to scale.

Enhanced DRX (eDRX)

eDRX is modified form of Idle Mode DRX. It allows the chipset to switch OFF its receiver for extended window of time. During these sleep cycles, IoT device cannot be reached. Importantly, not every MNO network supports eDRX.

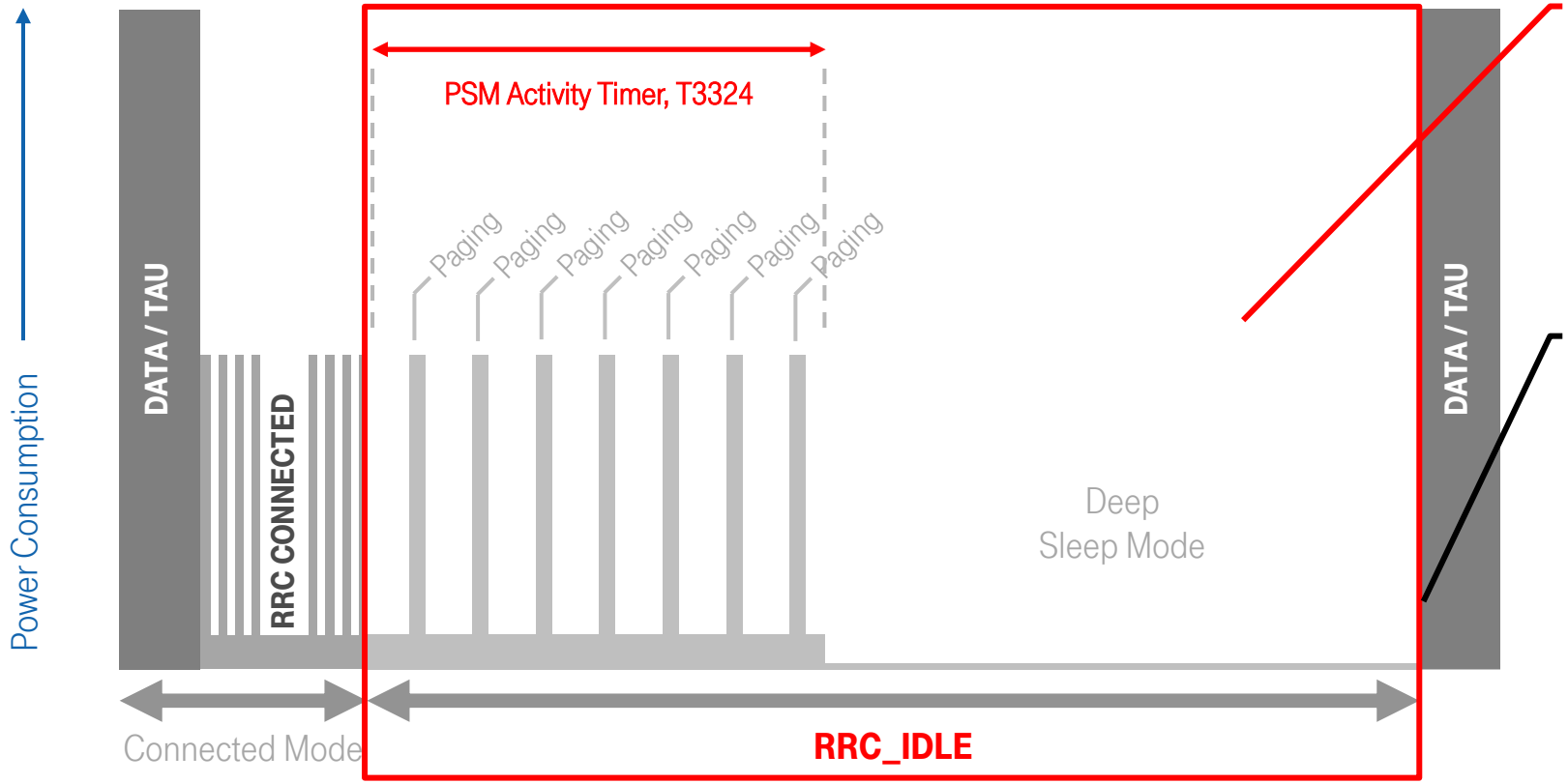


A DRX procedure (4-16 paging reception slots) is performed in fixed **Paging Transmission Windows (PTW)**, configurable by the IoT application

Subsequent PTWs are offset from each other by a second timer, T_{eDRX}, the **eDRX Cycle**; this timer can be configured by the IoT application

Power Saving Mode (PSM)

PSM is ideal for Uplink-centric IoT applications that never need to reached or triggered (pull) by the IoT server. It allows the chipset to shut down its transceiver and conserve significant amounts of energy, prolonging battery life.

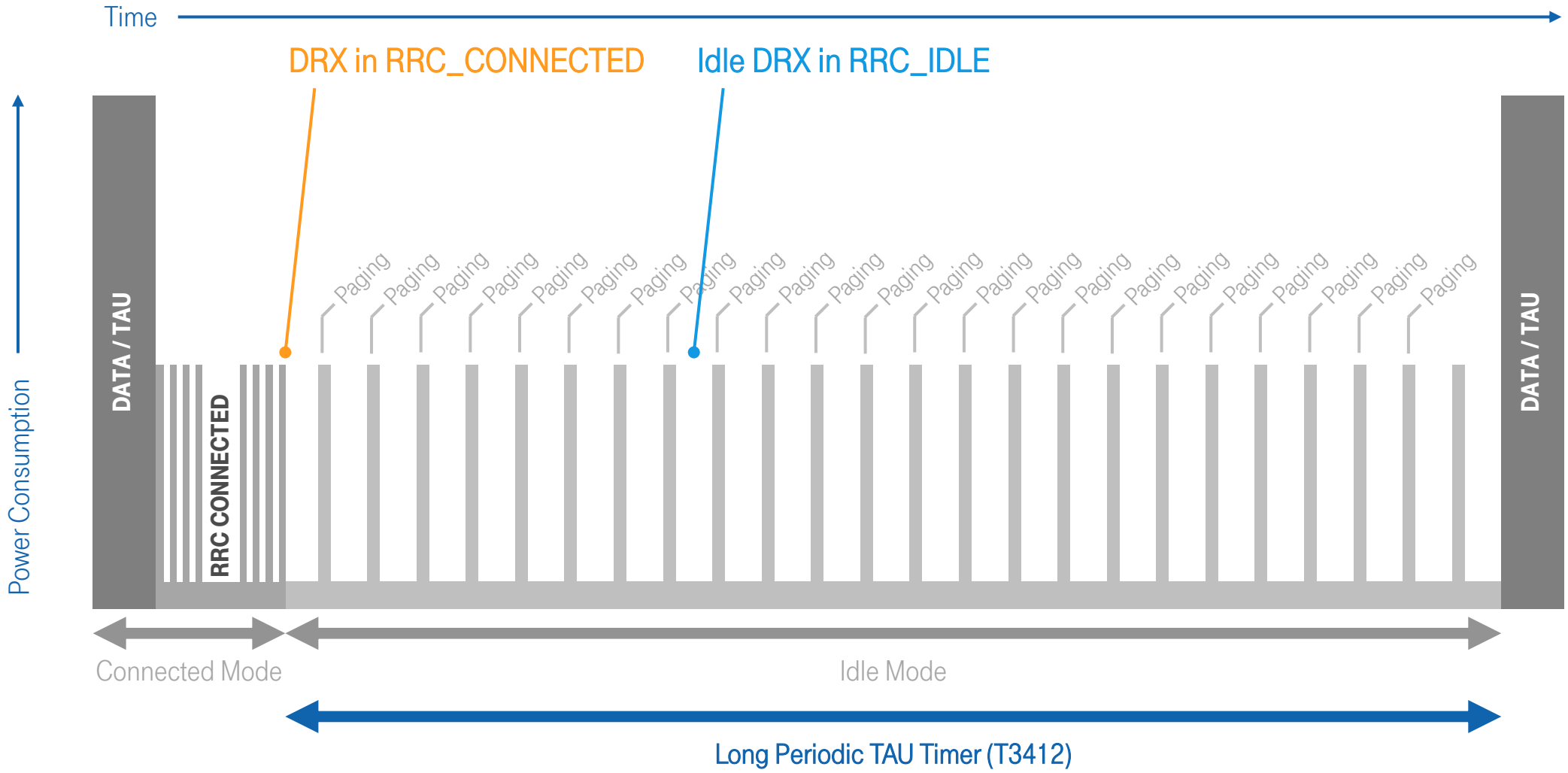


WARNING!

The IoT device cannot be reached during the PSM deep sleep; use only if appropriate!

Once the IoT device wakes up, it must perform a TAU or send an application message

LP. TAU + (EDRX=0, PSM=0, CDRX=1, RAI=0)



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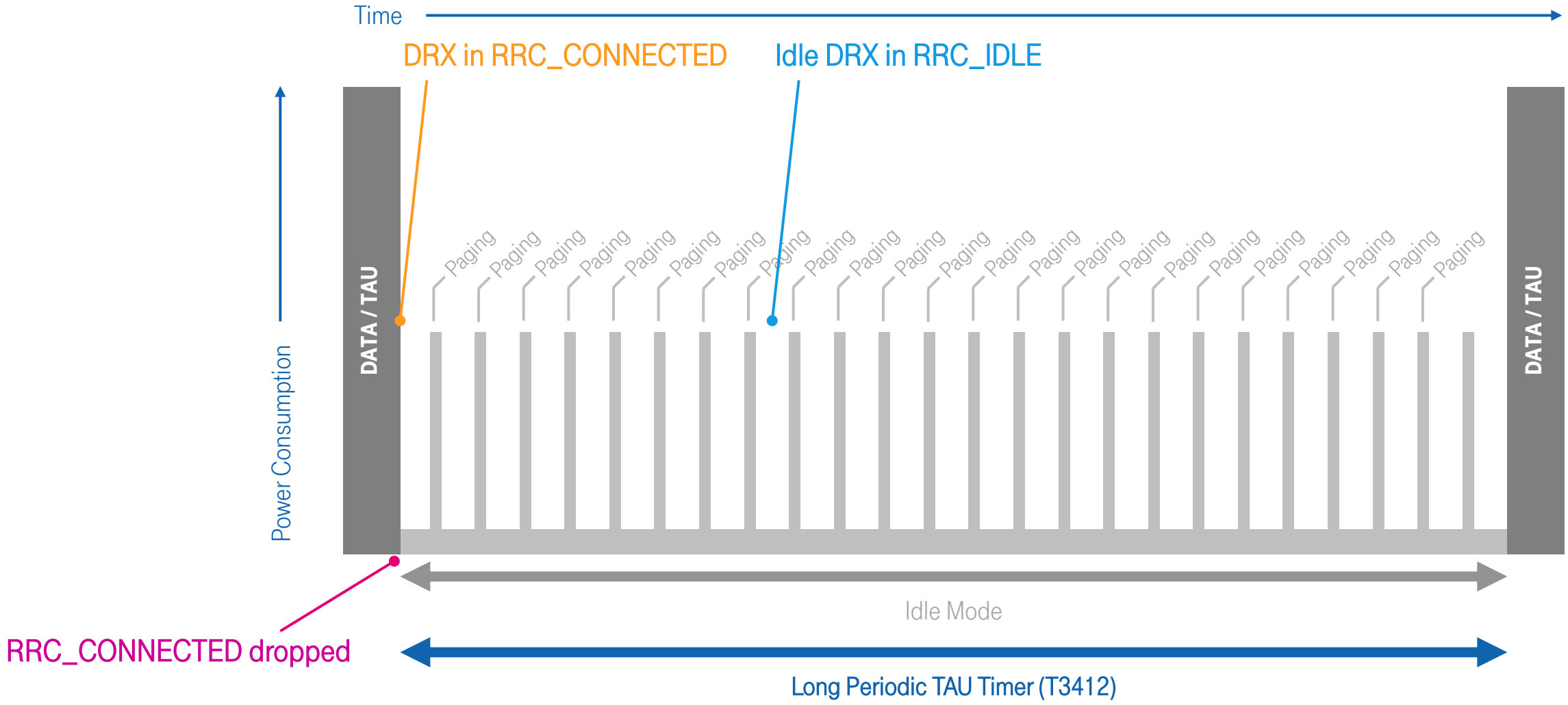
LP. TAU + (EDRX=0, PSM=0, CDRX=1, RAI=1)



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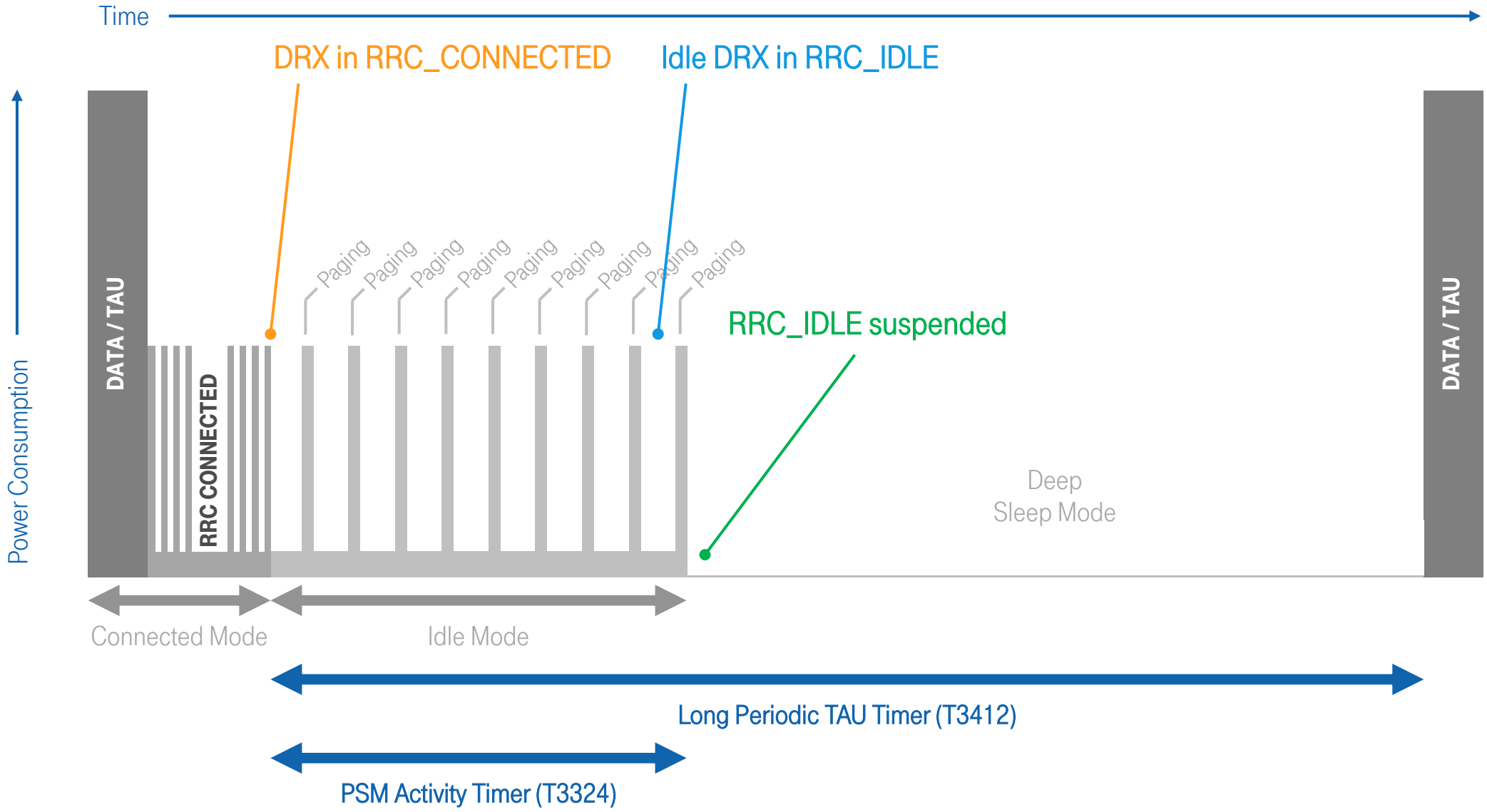

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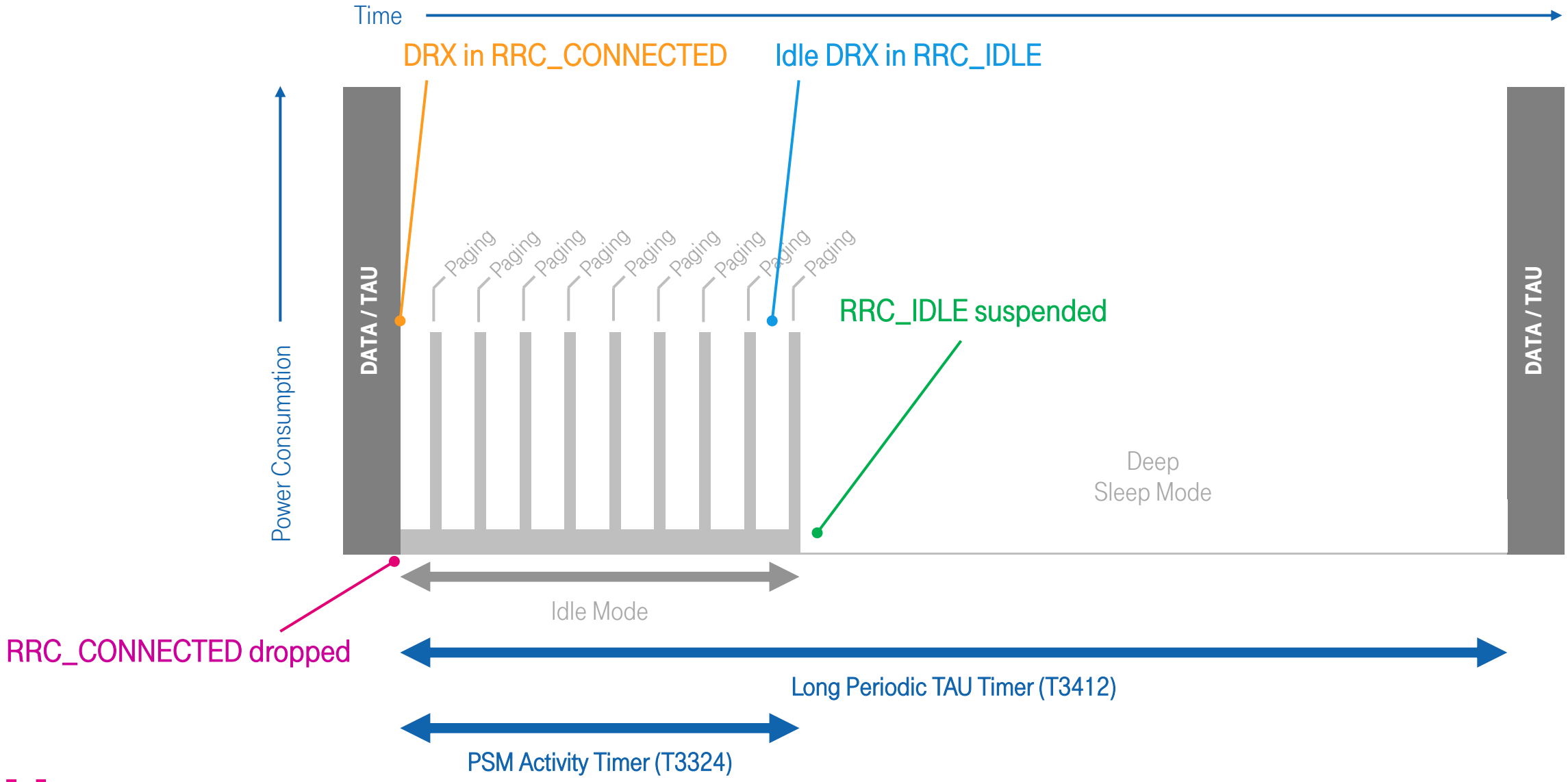

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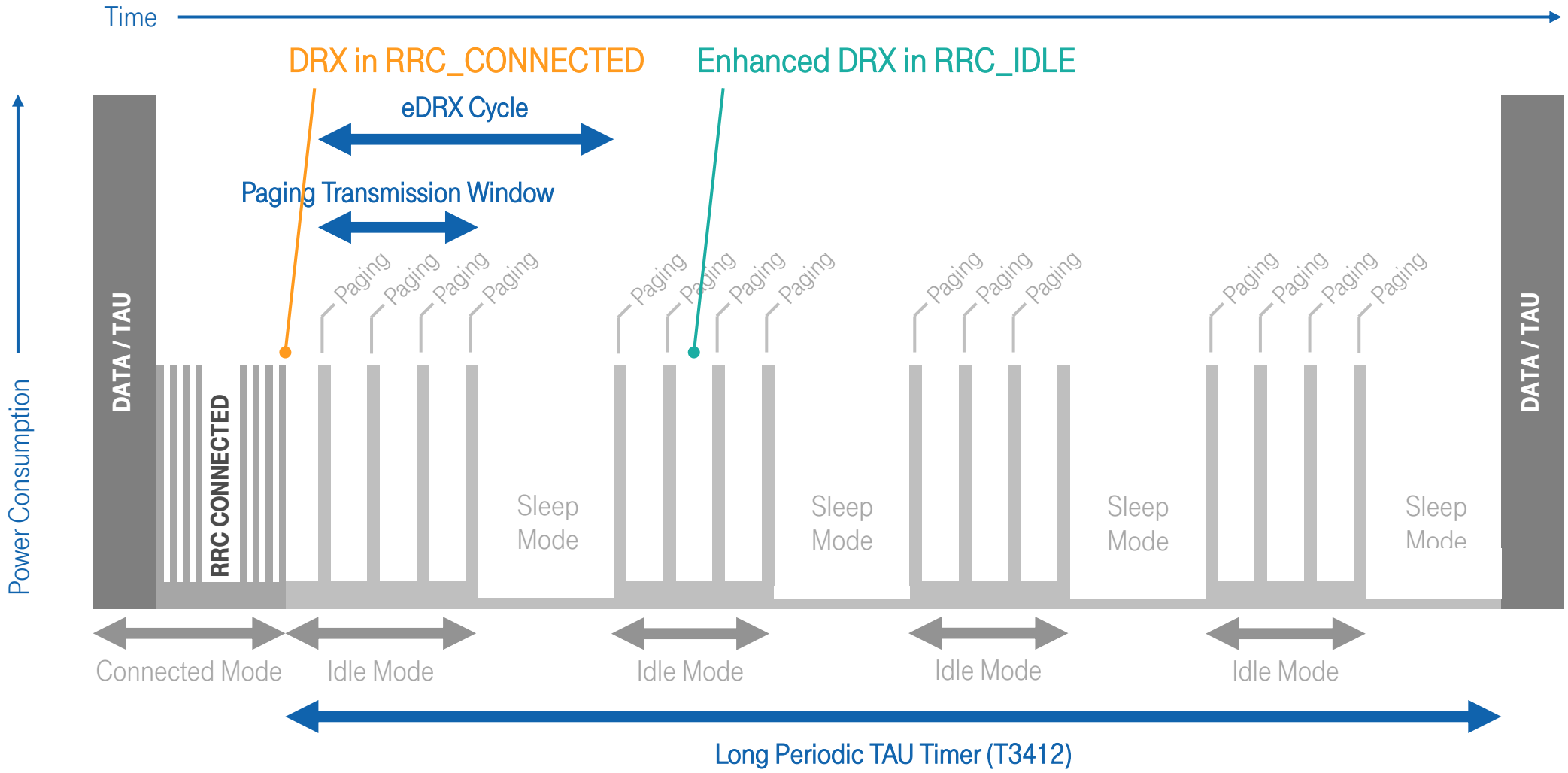

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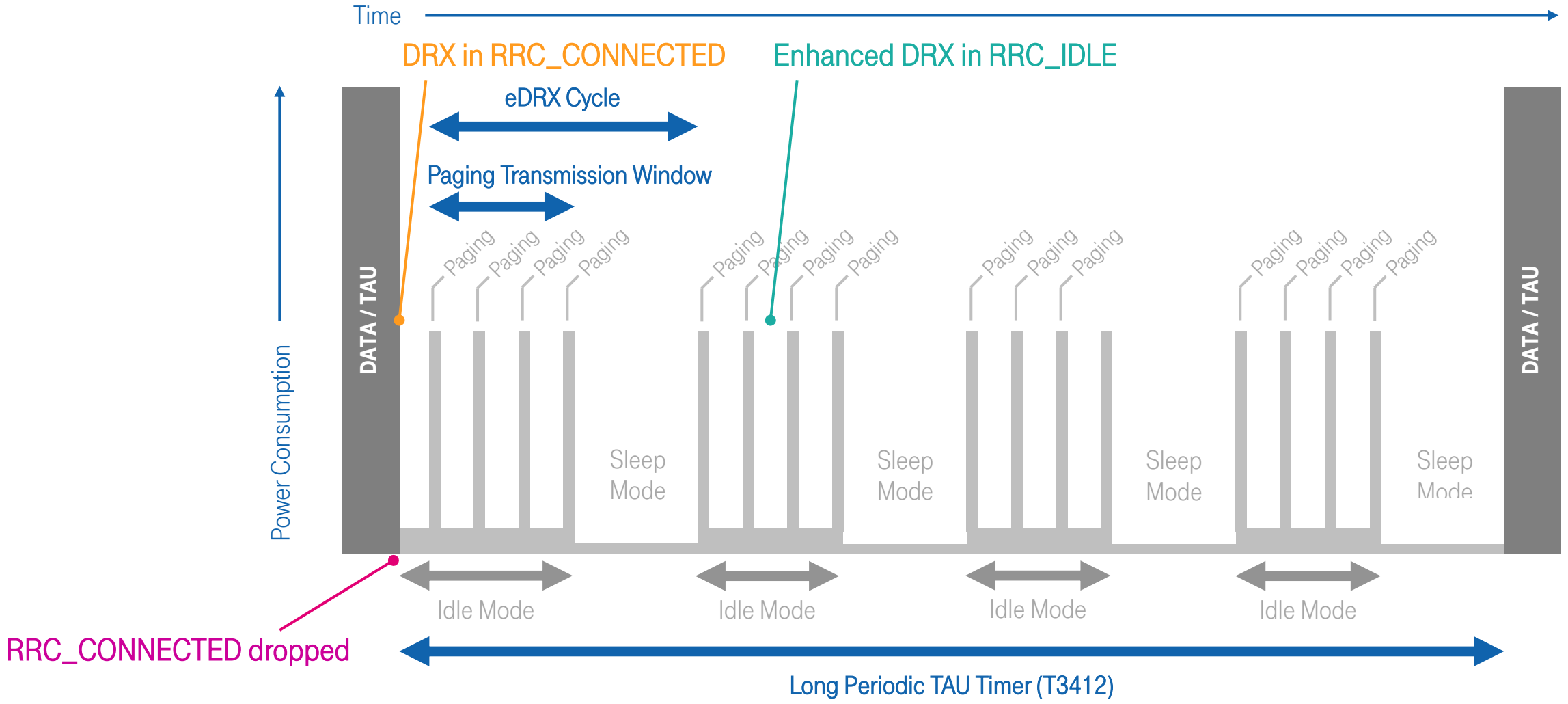
LP. TAU + (EDRX=1, PSM=0, CDRX=1, RAI=1)



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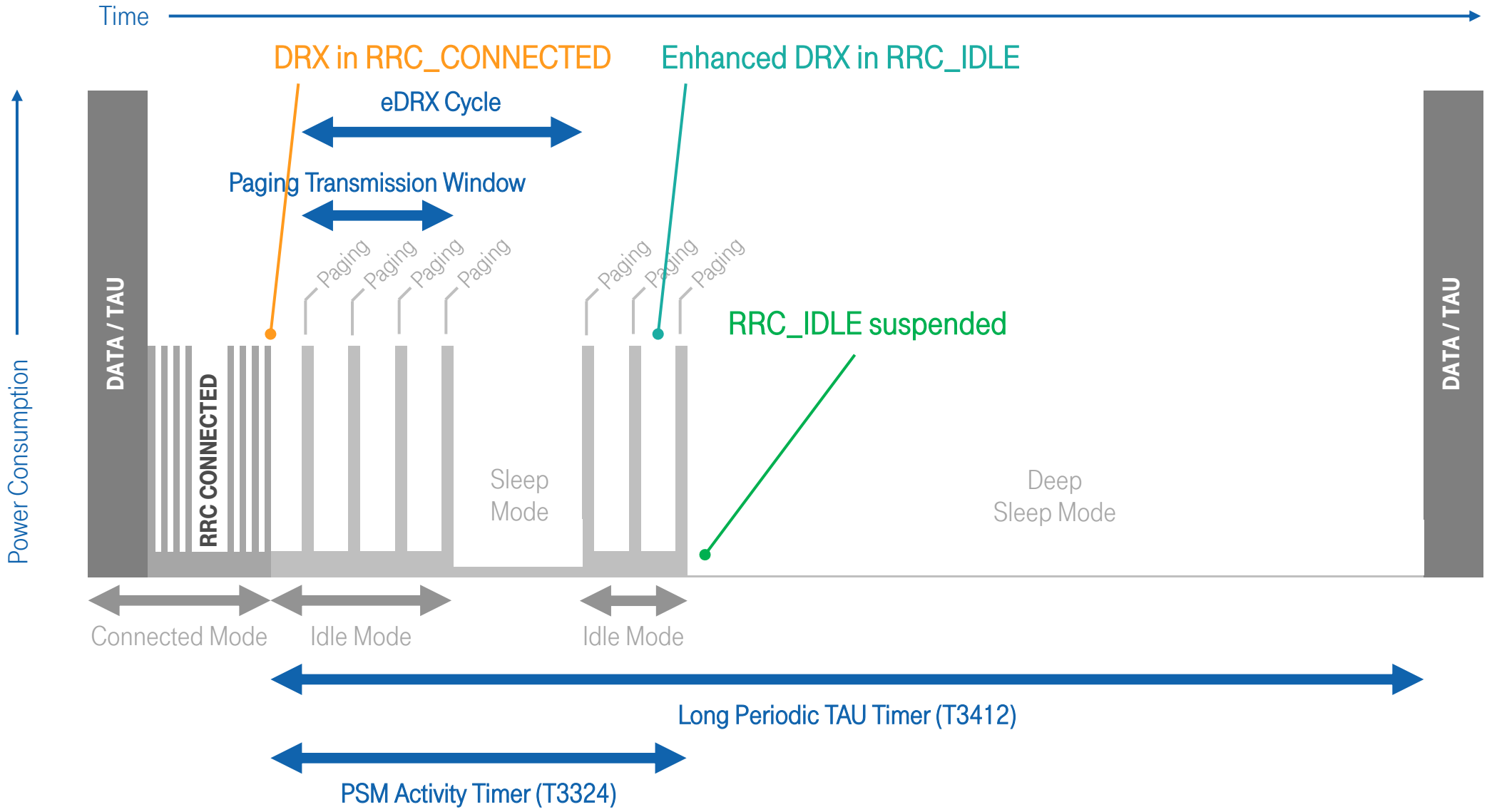
LP. TAU + (EDRX=1, PSM=1, CDRX=1, RAI=0)



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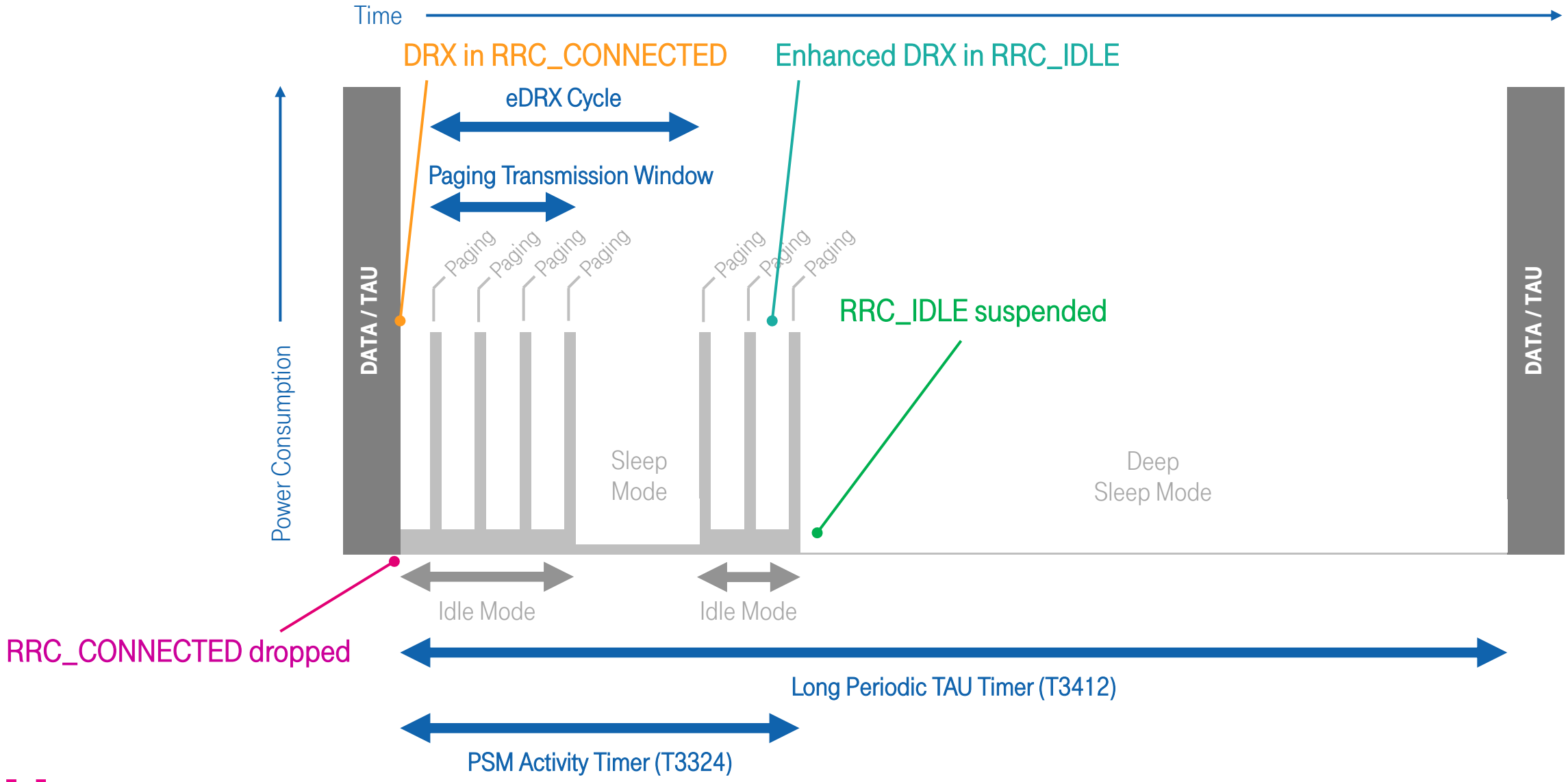
LP. TAU + (EDRX=1, PSM=1, CDRX=1, RAI=1)



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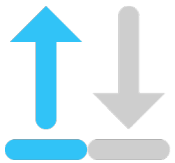
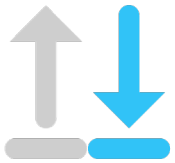
Example of what you might propose…

The more often IoT Applications interrupt power saving features, the less efficient they become…
Apply these features according to the specific use-case… more is not better!

	Long Periodic TAU	eDRX	PSM	RAI
Uplink-Centric Application				
 ▪ **Very Regular Reporting** (e.g. Smart Parking)	Beneficial if reporting interval > 186 min	✗	✓	✓
▪ **Regular Reporting** (e.g. Hourly Climate Report)		✗	✓	✓
▪ **Irregular Reporting** (e.g. Smart Metering)		✗	✓	✓
Downlink-Centric Application				
 ▪ **Very Regular Reporting** (e.g. Access Control)	Beneficial if reporting interval > 186 min	✗	✗	✗
▪ **Regular Reporting** (e.g. Ventilation Actuator)		✓	✗	✓
▪ **Irregular Reporting** (e.g. Irrigation Actuator)		✓	✓	✓