Factors Driving the Deployment and Acceptance of PTP

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Presentation overview

- Need for time synchronisation
- Using GPS for delivering time
- PTP with full timing support
- PTP with assisted partial timing support
- Conclusions

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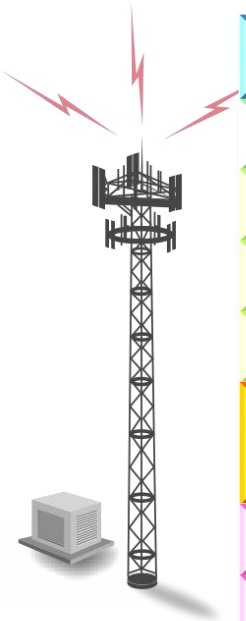
Need for Time Synchronisation

Synchronisation in the Mobile Backhaul



Application	Frequency	Time	Backhaul Spec
CDMA2000	**±50 ppb**	**±3 to 10 µs**	*(uses GPS for sync)*
GSM	**±50 ppb**	**N/A**	**±16 ppb** *(G.8261.1)*
WCDMA	**±50 ppb**	**N/A**	**±16 ppb** *(G.8261.1)*
LTE (FDD)	**±50 ppb**	**N/A**	**±16 ppb** *(G.8261.1)*
LTE (TDD)	**±50 ppb**	**±1.5 µs** *(< 3km radius)* **±5 µs** *(> 3km radius)*	**±16 ppb** *(G.8261.1)* **±1.1µs** *(G.8271.1)*
LTE-A MBSFN	**±50 ppb**	**±1 to 5 µs** *implementation dependent*	**±16 ppb** *(G.8261.1)* **±1.1µs** *(G.8271.1)*
LTE-A CoMP *Network MIMO*	**±50 ppb**		
LTE-A eICIC *HetNet Coordination*	**±50 ppb**		
Small Cells	**±100 ppb**	**N/A** (FDD) **±1.5 µs** (TDD) **±1 to 5µs** (eICIC)	**±33 ppb** **±1.1µs** *(G.8271.1)*
Home Cells	**±250 ppb**	**N/A** (FDD) **±1.5 µs** (TDD)	**±100 ppb** **±1.1µs** *(G.8271.1)*

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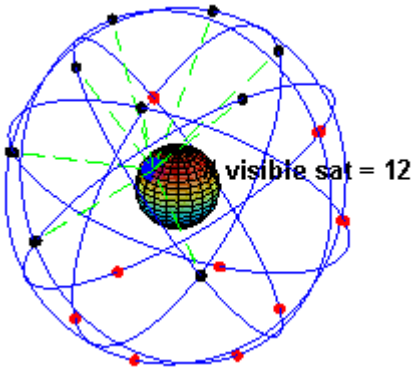
Using GPS to deliver time

GPS

Features

- 31 satellites providing global coverage
- Both Frequency and Time Synchronisation



Benefits

- Global coverage
- Fast deployment
- Frequency and Time Synchronisation available
  - Frequency accurate to better than PRC quality (0.01ppb)
  - Time accurate to within 100ns of UTC

Challenges

- Antennas need to have line-of-sight to multiple satellites
- Easy to jam both maliciously and inadvertently
- Cost can be high to deploy and maintain
- Political issues – do you want to be dependent on the US Navy?

Some GPS “availability issues”

Moss Landing, 2002:
GPS jammed across the harbour for several months by faulty TV antenna*

Newark, 2009-2011:
FAA take 18 months to trace a “personal privacy device” intermittently jamming the GPS system at Newark airport

San Diego, Jan. 2007:
US Navy unintentionally jam GPS in San Diego harbour during an exercise

Washington, Jan. 2011:
FCC permits Lightsquared to operate terrestrial transmission in a band adjacent to the GPS (Rescinded, Feb. 2012)

Korea, Dec. 2010:
N. Korea jams GPS in Seoul. Repeated several times in following years

Most of the issues are in the USA, where you would expect GPS to work best!

*See http://gpsworld.com/the-hunt-rfi/

The real culprit…

No, not the antenna, ***it's the WEATHER!***

Operator Requirement

“When the GPS fails (for whatever reason), the system must remain operational for 3 days, to allow time to fix it”

- **For frequency:**
  - Some operators use Rubidium oscillators to provide holdover at the basestation
  - Holds a few parts per billion over 72 hours
- **For time:**
  - Rubidium clock will hold 1µs for 8 hours
  - Caesium clock (PRC quality) will hold 1µs for 1 day
  - 1µs over 72 hours is approx. 0.004ppb:
    - 2½ times stricter than the PRC requirement (0.01ppb)
    - 12500 times stricter than the basestation frequency requirement

How to meet the holdover requirement

Local Oscillator Holdover

- Frequency holdover to within 50ppb for 72 hours is practical
  - Can use Rubidium or dual-oven quartz technology
- Time holdover – no oscillator technology will achieve the required performance of 1µs over 72 hours (at a viable cost)
- Therefore need an alternative strategy for “time protection”

Assisted Holdover

- Use an accurate, stable frequency source to maintain the local timebase, e.g. SyncE
- Use a time distribution technology such as PTP

The remainder of this presentation will focus on the PTP option

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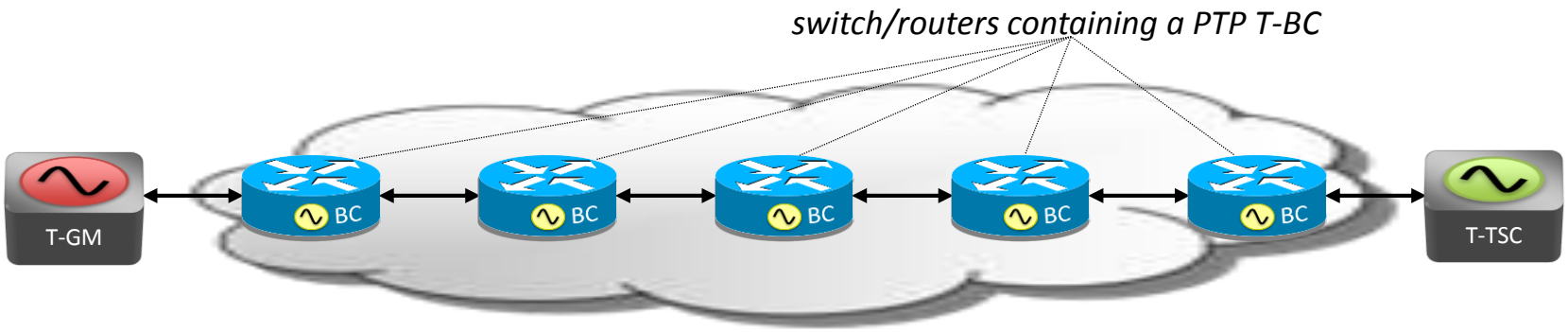
PTP with Full Timing Support

PTP with Full Timing Support



every switch/router on the path between T-GM and the T-TSC contains a T-BC

Features

- Every element in the path must be “PTP aware”
- T-BC case covered in standards, but use of T-TCs is also possible.
- Can use a combination of SyncE & PTP, where SyncE provides the frequency and the PTP the phase/time

PTP with Full Timing Support

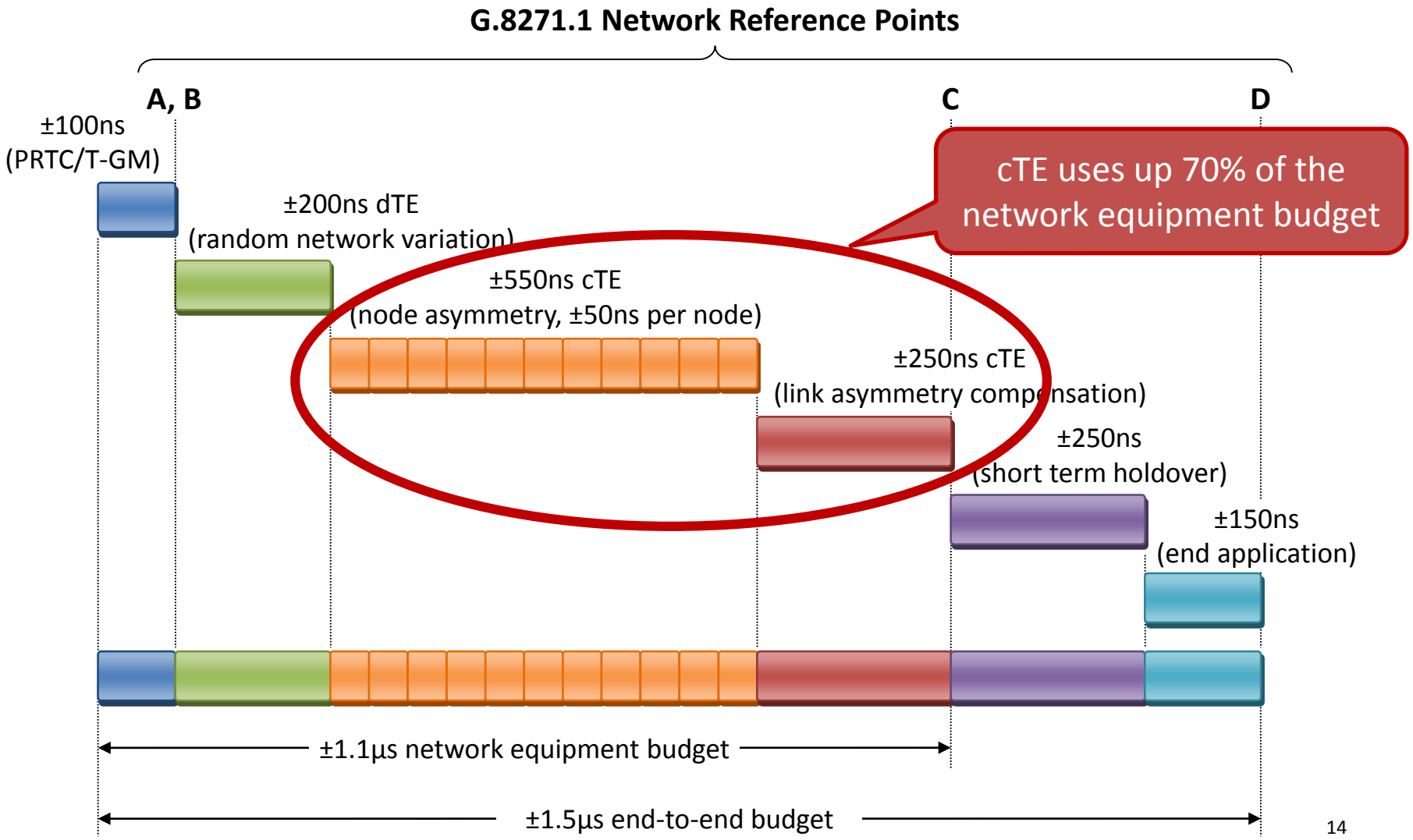
Benefits

- Controlled, deterministic environment suitable for both frequency and time/phase transfer
- “Building block” approach to network construction, with example time error budgets in G.8271.1
- Profile, architecture and clock specifications defined in ITU-T, to be consented at the next plenary meeting in Feb. ‘14

Challenges

- All equipment in path needs to be PTP aware
- No control of asymmetry in the network

G.8271.1: Time Error Budget Example



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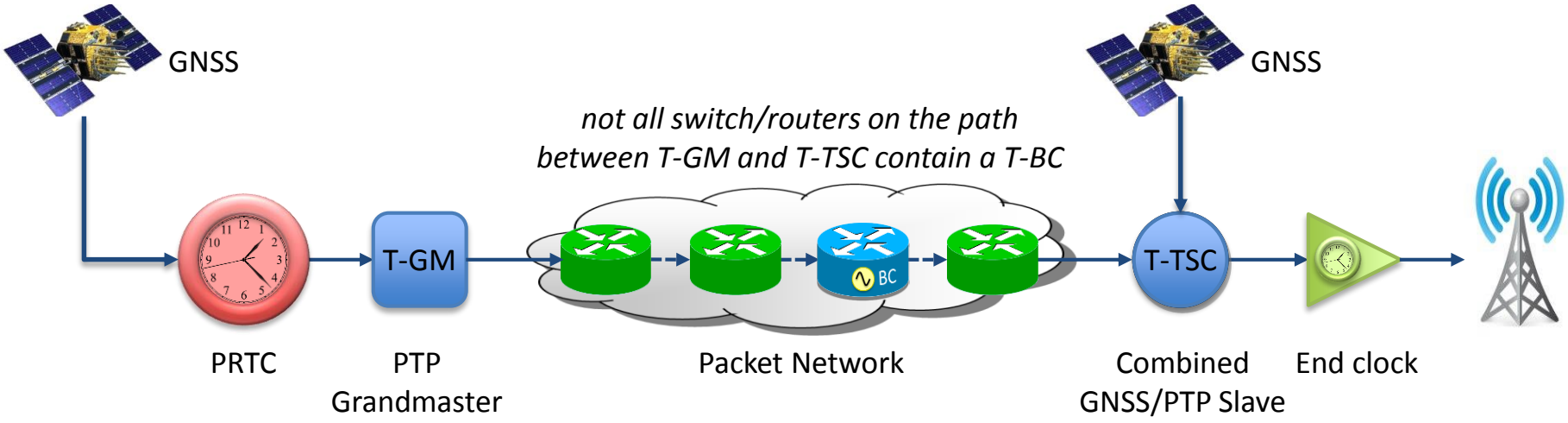
PTP with Assisted Partial Timing Support

Assisted Partial Timing Support



Features

- Many basestation sites already have GNSS installed (e.g. CDMA2000)
- Object is therefore backup to GNSS: i.e. ***"assisted holdover"***
- Can use GNSS when in service to monitor PTP service quality and measure network asymmetry
- PTP can maintain timebase when GPS is out of service (e.g. due to jamming or antenna failure)
- ITU to focus on "Assisted Partial Timing Support" next

PTP with Assisted Partial Timing Support

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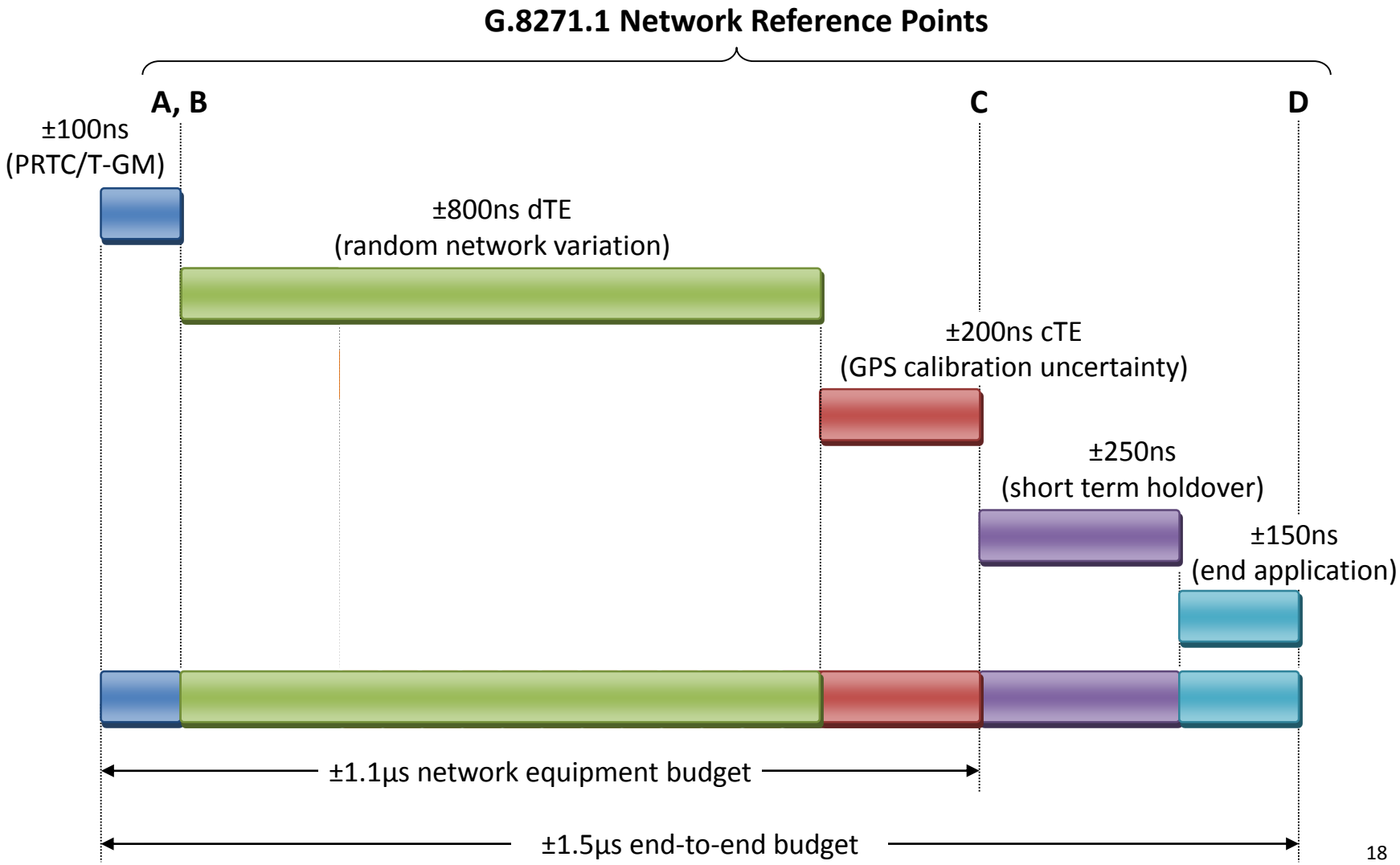
Benefits

- Synergistic operation of GNSS and PTP
  - PTP gives an initial rough time fix that can be used to assist the GNSS in signal acquisition mode
  - GNSS calibrates the PTP asymmetry, and monitors its suitability for service
  - PTP can monitor GNSS timing quality, e.g. antenna failure, spoofing, jamming
- Operates over existing networks, including third party access networks that may not have built-in PTP support
- Profile, architecture and clock specifications under definition in ITU-T, planned for consent in December 2014

Challenges

- Less deterministic path from T-GM to T-TSC, because not every network element assists in the timing flow
- May need constraints on traffic load and span of the packet network

APTS Time Error Budget Example



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Conclusions

Conclusions

- Every technology has its weaknesses and needs a backup
  - There's a reason why we always talk about the weather!
- GNSS and PTP have a synergistic relationship: each can help the other
- Difficult to see how partial timing support will work in the absence of GNSS for calibration of constant time error
- Assisted Partial Timing Support is an APT technology for GNSS backup over existing backhaul networks

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