RECENT ADVANCEMENTS IN G3-PLC AND INTRODUCING G3-PLC HYBRID

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RENESAS ELECTRONICS EUROPE ON BEHALF OF THE G3-PLC ALLIANCE

AGENDA

COMPANY PROFILE AND RELATIONSHIP WITH G3-PLC ALLIANCE

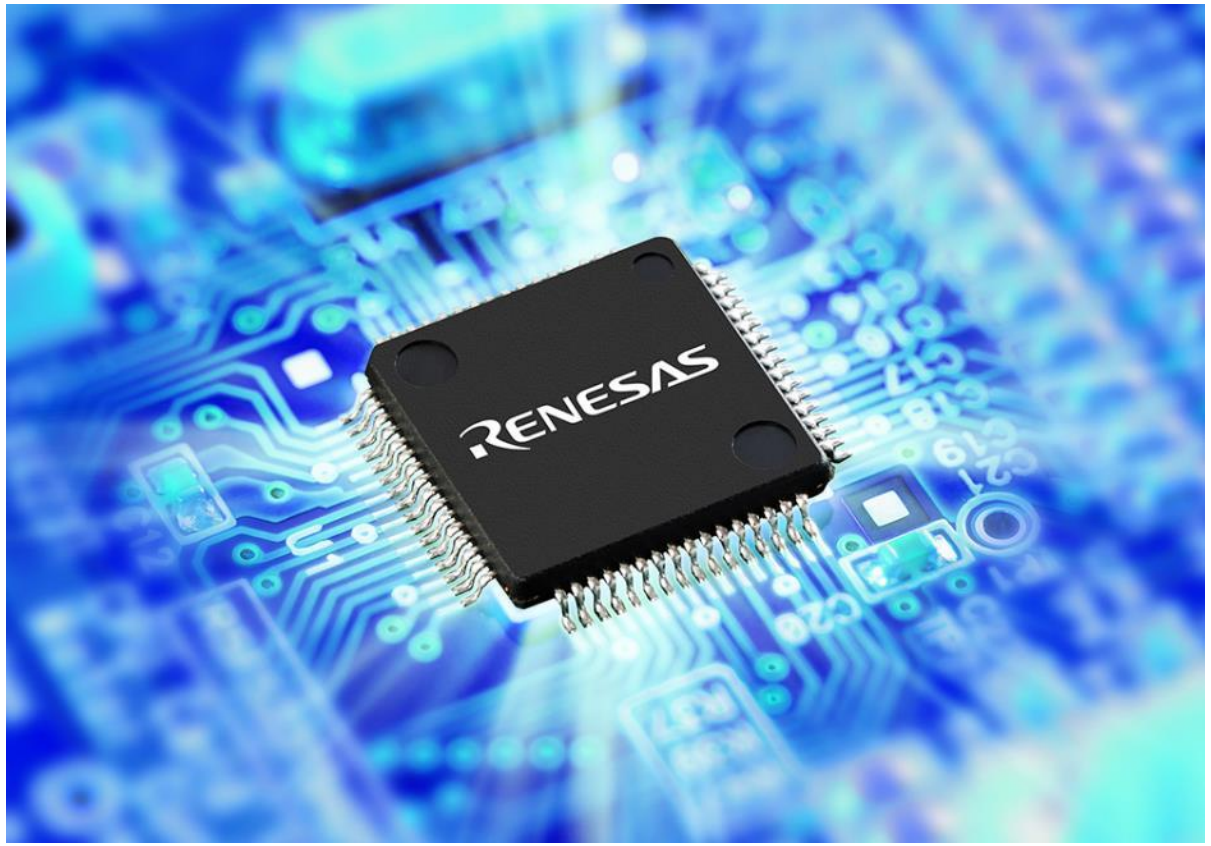
COMPANY PROFILE : RENESAS ELECTRONICS CORPORATION

THE WORLD-LEADING EMBEDDED SOLUTION PROVIDER

Renesas is a global semiconductor company delivering trusted embedded design innovation with complete semiconductor solutions that enable billions of connected, intelligent devices to enhance the way people work and live.

- Leads globally in Microcontrollers, Analog, Power, and SoC products
- Focuses on a broad range of Automotive, Industrial, Infrastructure, and IoT applications

- Renesas joined the G3-PLC Alliance in Oct ‘2011
  - Involved in the very first interop events for PHY/MAC/ADP in October 2012
  - First certified platform in being available in Oct 2014
- Renesas became an Executive Member of the G3-PLC Alliance in June ‘2019



RECENT ADVANCEMENTS IN THE G3-PLC SPECIFICATION

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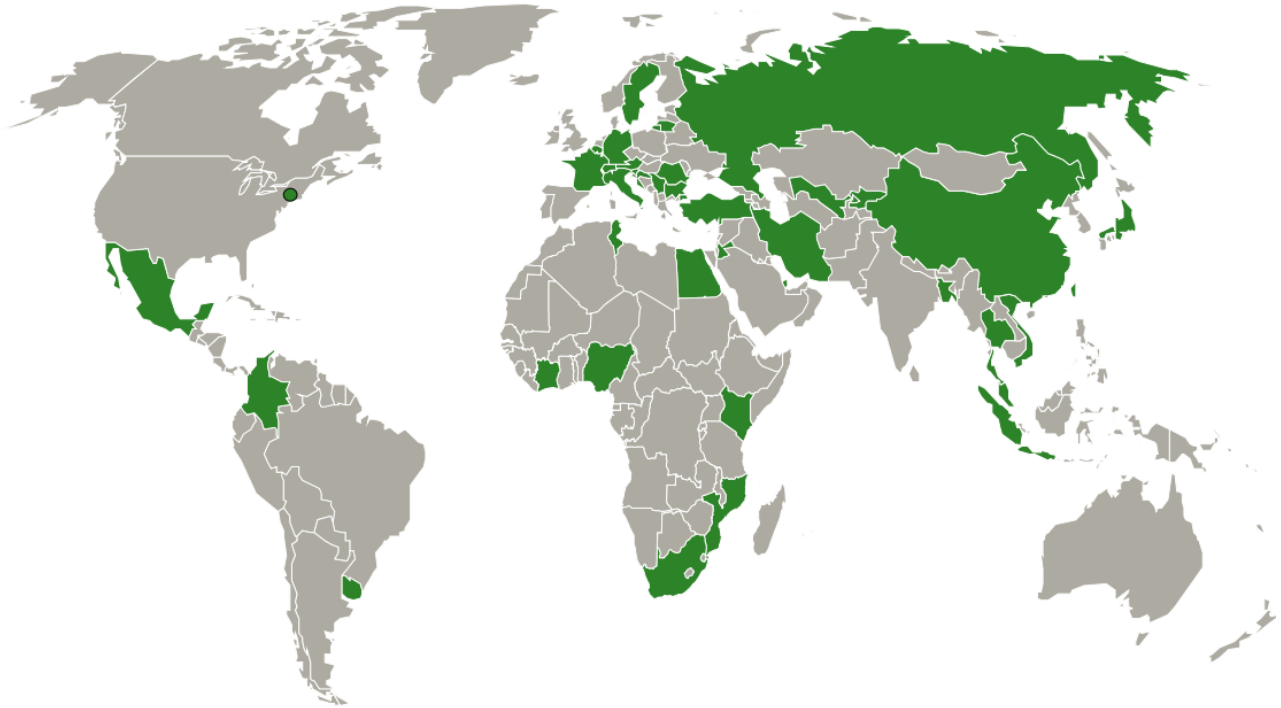
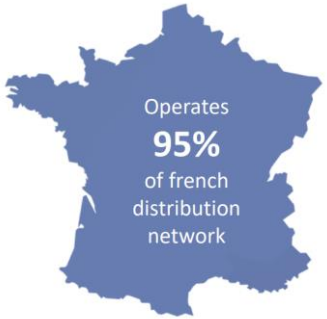
HISTORY

- G3-PLC is a mature technology with over 50 million G3-PLC products in operation in more than 30 countries





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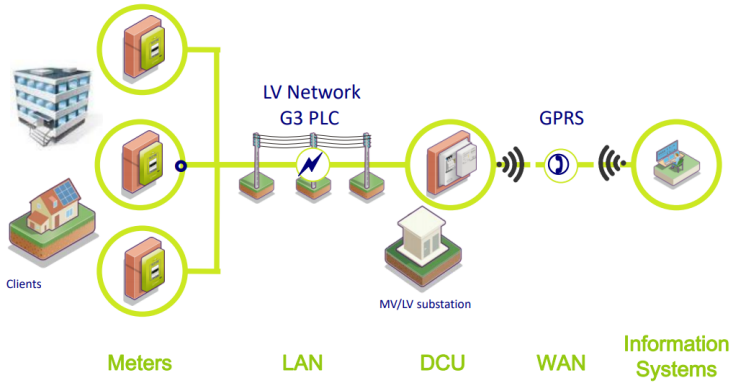


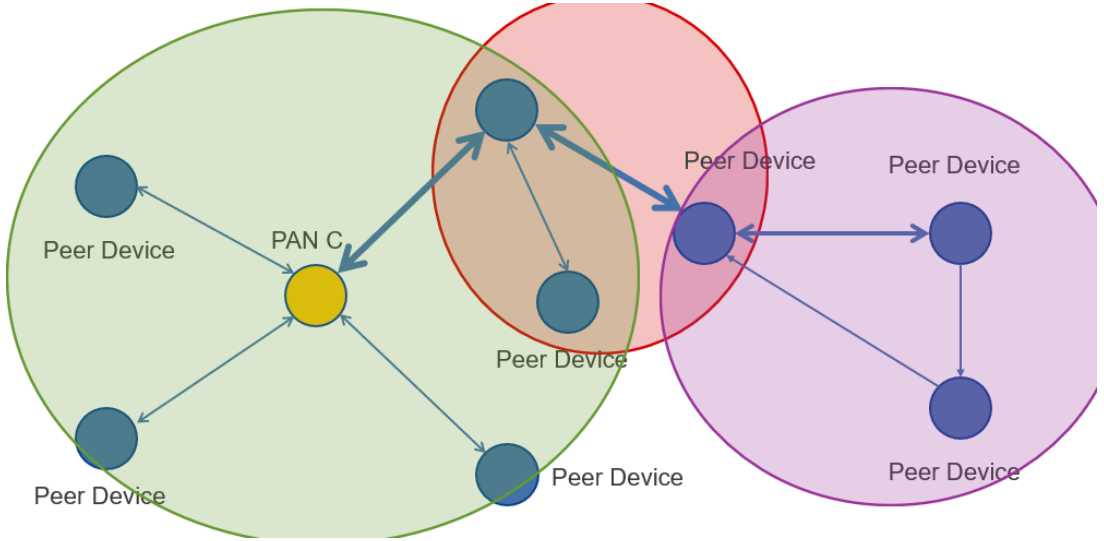
>98% DAILY COLLECTION RATE (11.59 PM)

>3 billion DATASETS **COLLECTED** / TRANSFERRED / STORED PER DAY

RECENT ADVANCEMENTS IN THE G3-PLC SPECIFICATION

ROUTING PROCEDURE AND BROADCAST FRAMES

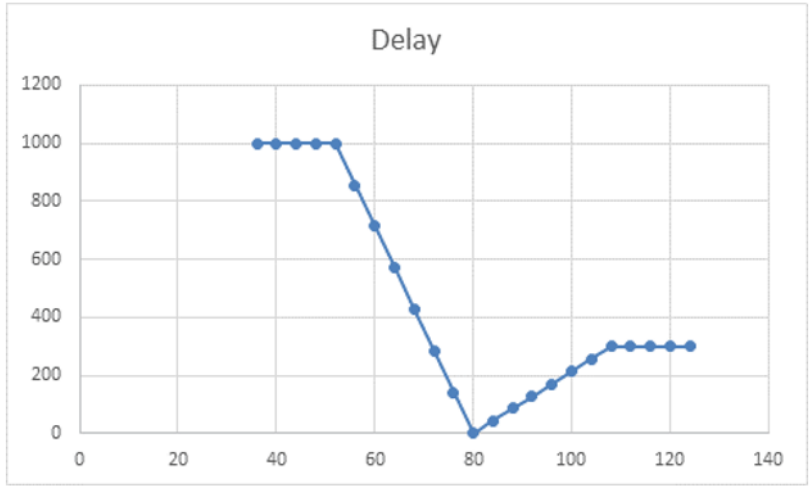
- G3-PLC uses LOADng - Lightweight On-demand Ad hoc Distance-vector Routing Protocol – Next Generation (LOADng)
- In Dense networks this cause a lot of routing traffic, in broadcast this is many frames in the network – leads to collisions.
- The G3-PLC Alliance has been working on enhancements to optimise and make the specification more efficient in dense networks.
  - ETT_DLL_35: Jitter in RREQ transmission
  - ETT_DLL_37: Broadcast optimisation using Trickle
  - ETT_DLL_38: Implementing Clusterhead.



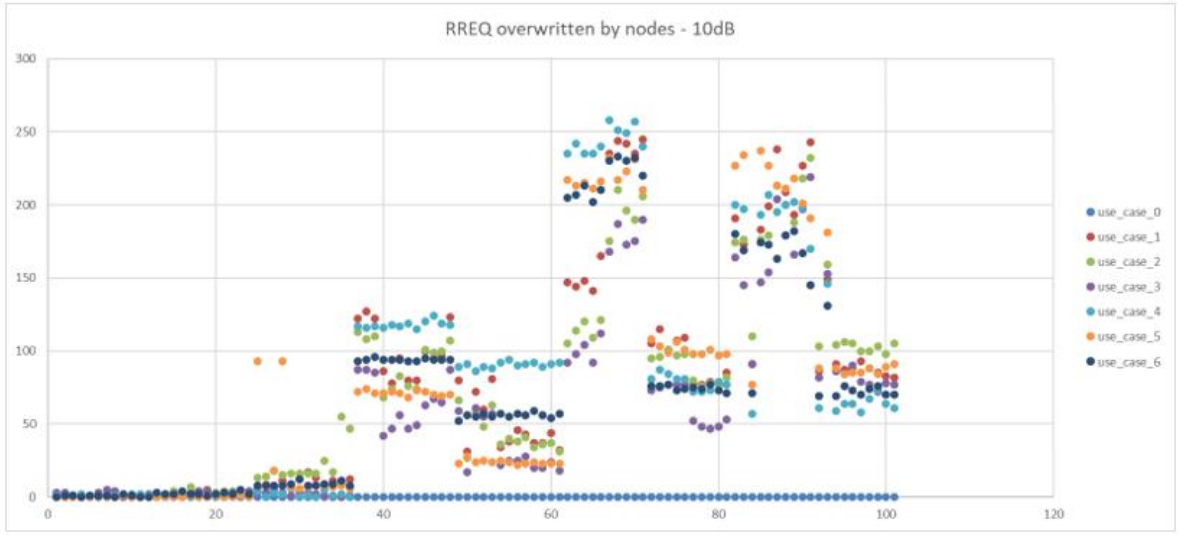
RECENT ADVANCEMENTS IN THE G3-PLC SPECIFICATION

ETT_DLL_35: JITTER IN RREQ TRANSMISSION

- Idea is to introduce a delay [controlled jitter] before forwarding a RREQ frame.
- Favour fast retransmission of RREQs likely to cause “good” routes.
- The delay is related to the quality of the route being advertised by each RREQ.
- Adding a delay means better route requests can replace pending RREQs
- Only the best RREQ will be forwarded.



- A significant reduction in RREQ traffic!
  - In some cases around 50%.
  - Less collisions – better routes.
- Still allowing the best routes to be chosen.

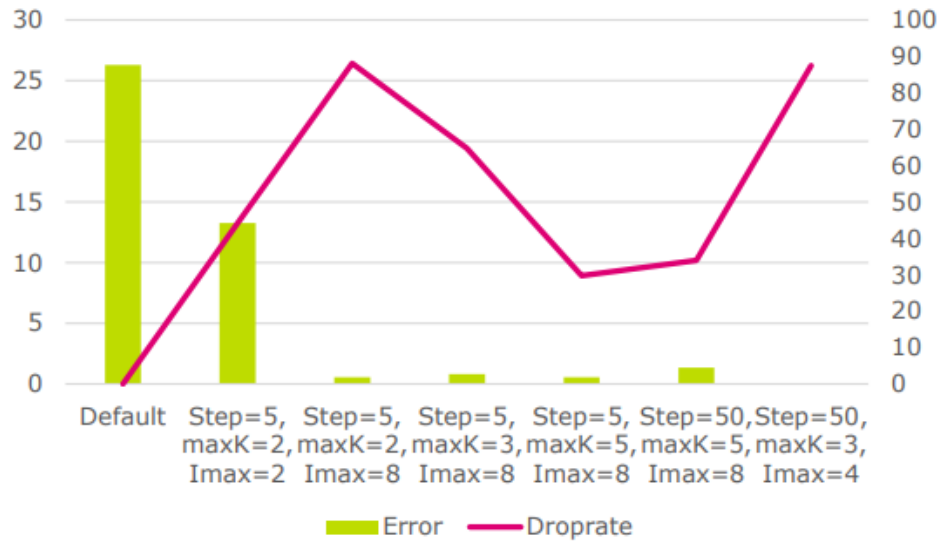


RECENT ADVANCEMENTS IN THE G3-PLC SPECIFICATION

ETT_DLL_37: BROADCAST OPTIMISATION USING TRICKLE

- G3-PLC Broadcast mechanism has room for improvement
  - All nodes attempt to retransmit the multicast frame.
  - Flooding leads to collisions and channel access problems – deteriorating performance
- Trickle:
  - Upon reception of a broadcast frame, set an interval timer.
  - A counter is incremented each time a node receives the “same” broadcast frame is received
  - If the counter is below a threshold at a given time: then retransmit the frame, otherwise it is discarded.
  - More nodes receive the broadcast frame with less traffic.

Test results from a ~330 node test network:



Frame size: 350 bytes, Interval length: 15s, Network requires at least 2 ROBO hops

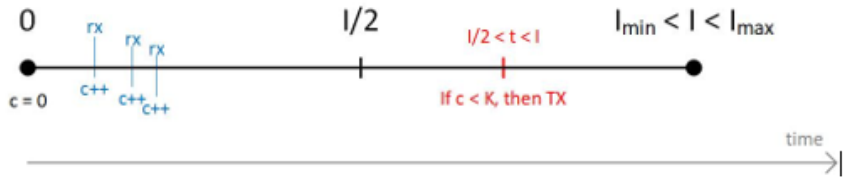
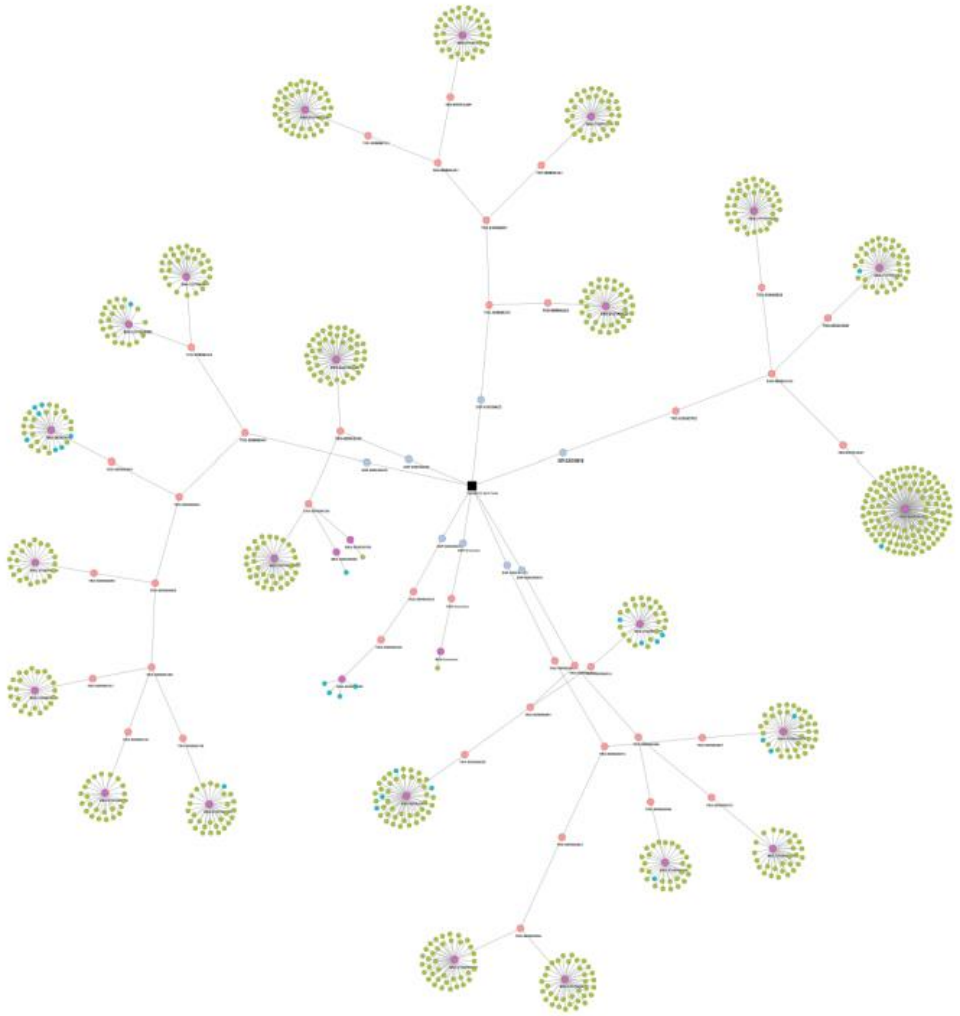


Figure 1 : General principle of the application of the Trickle algorithm over interval I

RECENT ADVANCEMENTS IN THE G3-PLC SPECIFICATION

ETT_DLL_38: IMPLEMENTING CLUSTERHEAD.

- In dense networks not all nodes need to LOADng routers.
- Instead one router may serve as a repeater for all nodes within its neighbourhood
- Automatic rules for each node to become or stay a clusterhead apply.
- Test are ongoing withing G3-PLC Technical Working Group.



RENESAS INTERNAL REAL WORLD NETWORK TEST ENVIRONMENT

State of the art testing on ~450 Modem Modules

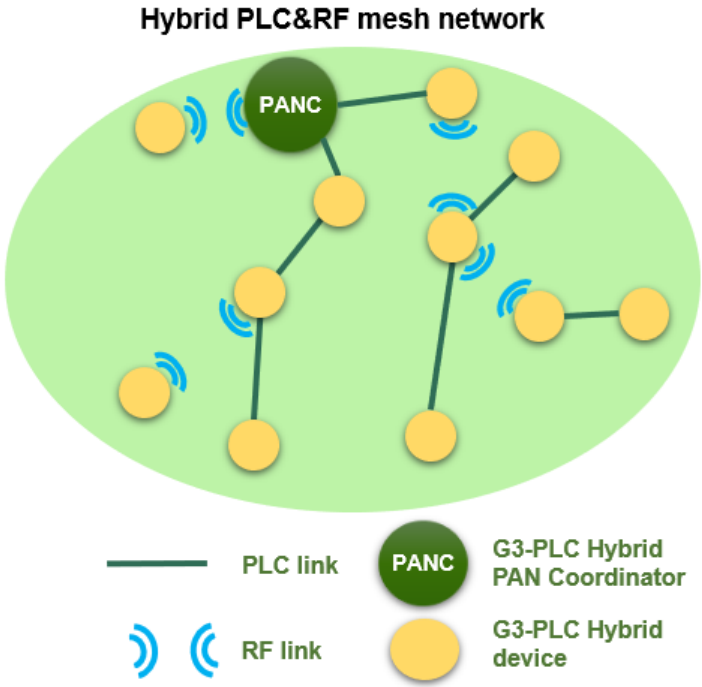
INTRODUCTION TO G3-PLC HYBRID

INTRODUCTION TO G3-PLC HYBRID
NETWORK

- G3-PLC is a stable and mature technology, data collection rates of >98%
  - Challenges: High Noise levels, remote areas
- There are also competing RF standards for smart metering.
  - Challenges: High interference, spectrum congestion, RF needs multiple repeaters, environment
- Neither technologies consistently reach >99% data collection.

- G3-PLC Hybrid combines an existing and proven RF technology
  - Fully backwards compatible with existing G3-PLC implementations

- Combined:
  - Maximises connectivity and reliability.
  - Extends the connectivity of G3-PLC to RF only devices.



802.15.4 SUN-FSK

INTRODUCTION TO G3-PLC HYBRID

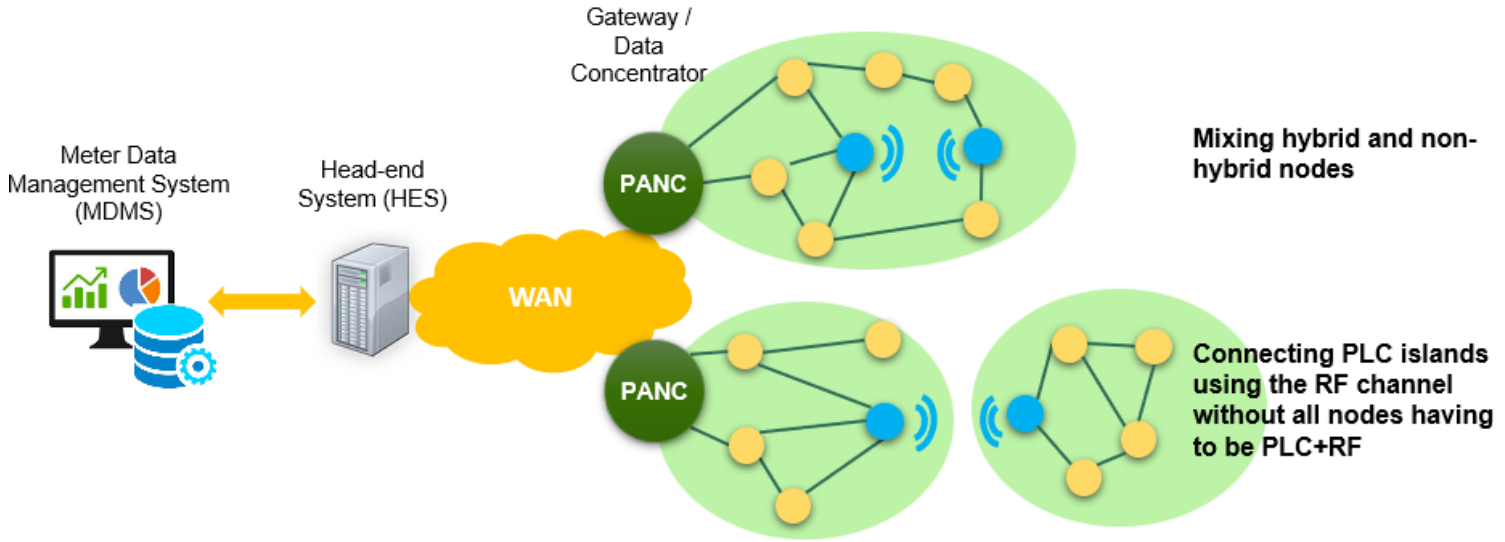
G3-PLC ALLIANCE STATUS

- G3-PLC Alliance Status
  - Specification development started in February ‘2020 and “Final” specification finished in July 2020.
  - G3-PLC RF MAC layer and G3-PLC Hybrid 6LoWPAN layer: IOT and Plug-fest – June 2020.
  - 5 Vendors took part and were all successful.
  - Hybrid certification tool has been developed and is now in testing at certification LABs
- On track for platform and products certifications to be available by End 2020.

- New frequency bands and frequency hopping now under planning.

INTRODUCTION TO G3-PLC HYBRID
EARLY TRIALS

- Early implementations of the next generation G3-PLC Hybrid (which is still to be certified) has been tested in a tough network
- The first results with 5.000 meters showed daily reading rates of 98-99,7%.
- A full-scale project with 40.000 G3-PLC Hybrid smart meters has now been launched in Russia.
- Additional large-scale trials are planned in the upcoming months in several regions.



SUMMARY

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- G3-PLC has proven its robustness in the 50+ million devices already deployed worldwide.
- G3-PLC Alliance is continuing to build and improve on the specification success.
- In addition to the existing profiles, the G3-PLC Hybrid now offers extended capabilities for the smart grid and IoT
- If you want to know more:
  - Visit the G3-PLC Alliance website: https://www.g3-plc.com/home/
  - Contact:
    - Leon Vergeer : leon.vergeer@g3-plc.com
    - Kevin Jones : kevin.jones@renesas.com

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