

PHASE MAPPING IN PLC PRIME NETWORKS



PRIME
ALLIANCE®

OBJECTIVE

WHY IS THIS INFORMATION NOT CURRENTLY AVAILABLE?



To obtain reliable information on the actual physical connection of the meter with respect to the header phases in the secondary substation

Low Voltage installations are usually designed arbitrarily or according to static construction criteria, and the information is not then transferred to DSOs, or is transferred incorrectly.

MOTIVATION

WHY IS THIS INFORMATION SO IMPORTANT?

It improves and facilitates **network operation** by means of load balancing per phase



Network unbalance detection

It improves **phase noise detection**

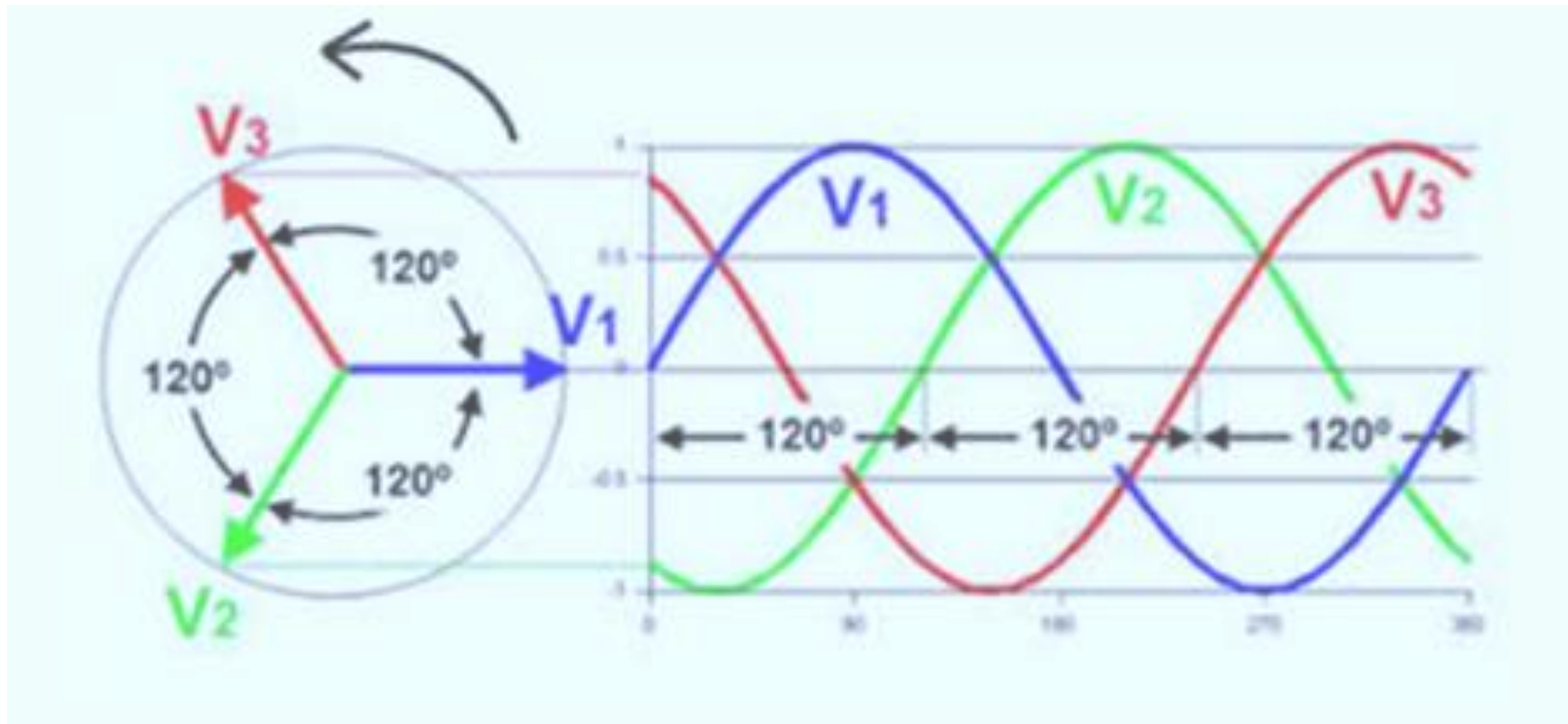
It allows to have a complete, accurate and updated **inventory of loads** in real time



Network unbalances cause serious network problems:

- Circuit overload, short-circuits, overheating

SOLUTION DESCRIPTION



SOLUTION DESCRIPTION

INTRODUCTION TO PRIME TECHNOLOGY

[PHY] OFDM modulation robust against impulsive and frequency-selective noise

[PHY] 96 subcarriers per channel (8 channels up to 500 kHz)

[MAC] node discovery and network convergence automatic mechanism

The base node (in the secondary substation) is the central element of the network and manages the topology.

The service nodes (embedded in the Smart Meters) are registered in the base node and can automatically behave as repeaters (switches)

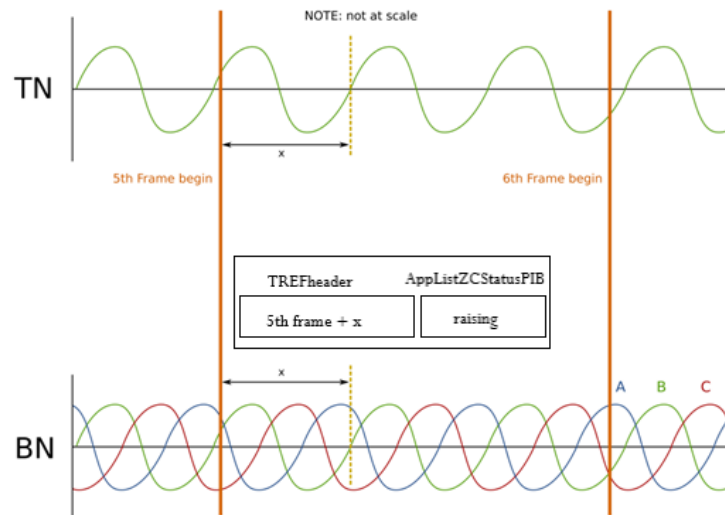
SYNCHRONOUS PROTOCOL→ The start time and duration of the frames are propagated through the network by means of “beacons” which are transmitted at fixed and known intervals, keeping the network synchronized with an unique time reference.

SOLUTION DESCRIPTION

EVENT TRANSMISSION

All nodes can reference and transmit time information relative to the frame start instant, a “network time” that all nodes understand and interpret.

Time event: zero-crossing time of the 50Hz signal, relative to the frame start instant



PRIME v1.4: The MAC subheader “Time Reference” is introduced, which allows nodes to exchange any temporal information (relative to the start of the frame)

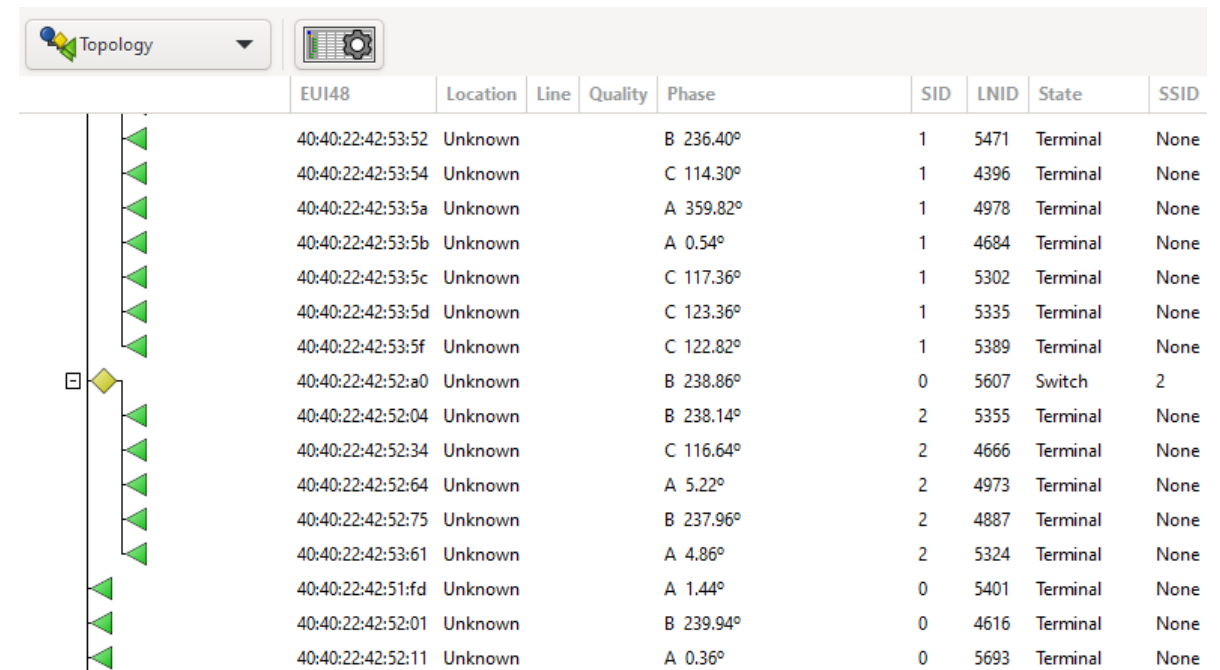
SOLUTION DESCRIPTION

PHASE IDENTIFICATION

The response of each service node to the AppListZCStantus attribute of the PIB includes in TREF the time reference of the zero crossing of its 50 Hz signal.

With this information, the base node knows the phase difference between the service node and its R-phase (considered as 0°).






The base node can transmit the phase difference for each registered service node. The phase difference is transmitted in angle units (between 0° and 359,99°) with respect to its phase and **it is possible to associate the phase of the node when the phase difference is close to 0°, 120° or 240°.**



| EUI48 | Location | Line | Quality | Phase | SID | LNID | State | SSID |
|-------------------|----------|------|---------|-----------|-----|------|----------|------|
| 40:40:22:42:53:52 | Unknown | | | B 236.40° | 1 | 5471 | Terminal | None |
| 40:40:22:42:53:54 | Unknown | | | C 114.30° | 1 | 4396 | Terminal | None |
| 40:40:22:42:53:5a | Unknown | | | A 359.82° | 1 | 4978 | Terminal | None |
| 40:40:22:42:53:5b | Unknown | | | A 0.54° | 1 | 4684 | Terminal | None |
| 40:40:22:42:53:5c | Unknown | | | C 117.36° | 1 | 5302 | Terminal | None |
| 40:40:22:42:53:5d | Unknown | | | C 123.36° | 1 | 5335 | Terminal | None |
| 40:40:22:42:53:5f | Unknown | | | C 122.82° | 1 | 5389 | Terminal | None |
| 40:40:22:42:52:a0 | Unknown | | | B 238.86° | 0 | 5607 | Switch | 2 |
| 40:40:22:42:52:04 | Unknown | | | B 238.14° | 2 | 5355 | Terminal | None |
| 40:40:22:42:52:34 | Unknown | | | C 116.64° | 2 | 4666 | Terminal | None |
| 40:40:22:42:52:64 | Unknown | | | A 5.22° | 2 | 4973 | Terminal | None |
| 40:40:22:42:52:75 | Unknown | | | B 237.96° | 2 | 4887 | Terminal | None |
| 40:40:22:42:53:61 | Unknown | | | A 4.86° | 2 | 5324 | Terminal | None |
| 40:40:22:42:51:fd | Unknown | | | A 1.44° | 0 | 5401 | Terminal | None |
| 40:40:22:42:52:01 | Unknown | | | B 239.94° | 0 | 4616 | Terminal | None |
| 40:40:22:42:52:11 | Unknown | | | A 0.36° | 0 | 5693 | Terminal | None |

CONCLUSIONS

NATIVE + RELIABLE + ACCURATE + INSTANTANEOUS + INTEROPERABLE METHOD

-  **Native**
The information is obtained directly from the PRIME nodes, it does not require any other type of sensor or algorithm.
-  **Reliable and deterministic**
Phases calculated correctly in 100% of meters
-  **Accurate**
The maximum deviation obtained in angle is very small, far from the uncertainty limit
-  **Instantaneous**
On demand. As another meter reading
-  **Interoperable**
All PRIME 1.4 nodes incorporate this functionality