

PTP is a very comprehensive protocol and there are several implementation profiles, called PTP Profiles. For the power system, the profile used is the Power Profile, which has specific implementation requirements related to the network layer, master and slave message types, and the time intervals of the PTP messages. The Power Profile is defined in IEEE C37.238-2011 and sponsored by the the Power Systems Relaying Committee and the Substation Committee of the IEEE Power and Energy Society. Below, Figure 1 shows the message rates of Power Profile.

Message	Message Interval or Trigger
Announce	1 second
Sync	1 second
Follow-up (two-step clocks only)	Triggered by sync message
Peer delay request	1 second
Peer delay response	Triggered by peer delay request
Peer delay response follow-up (two-step clocks only)	Triggered by peer delay response

Figure 1 - PTP Power Profile Message Rates

Regarding Process Bus synchronization by PTP, if the message intervals were reduced beneath than 1s, but without isolate PTP from the Process Bus traffic with VLAN, does it guarantee the synchronism? Considering the Sampled Values in the IEC 61850-9-2LE format at the rate of 4800Hz with 1ASDU, every 208.33 μ s a new SV frame has to be forwarded, thus the Ethernet network will already be loaded. Now, if consider more than 1MU to load the Process Bus even more, 10 MUs for example and the Switch latency around 2.25 μ s on 100Mb/s network. If a 9-2LE SV frame has 1000 bits of length, all the 10 MUs occupy 122.5 μ s of the 208.33 μ s, that means the PTP frames have only 85.83 μ s among the SV frames to be forwarded. Figure 2 demonstrates this example.

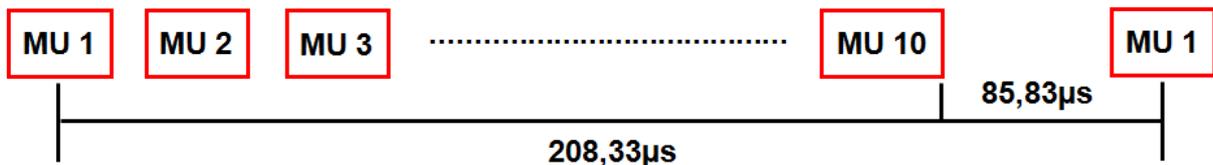


Figure 2 - MUs Forwarding Period

Considering the statistical multiplexing, it is impossible to guarantee that will not happen loss of PTP message during the sync cycle between Master and Slave. To exemplify this fact, during the experiments for the paper, not always happened losses of PTP frames during the 30 minutes of time testing, even with Process Bus traffic. Furthermore, an attempt was made in order to reduce PTP message intervals with Process Bus traffic, but in long time testing (30 minutes or more) still happened losses of PTP frames.