International Telecommunication Union

ITU-T

TELECOMMUNICATION
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G.9902

Amendment 2

(08/2013)

SERIES G: TRANSMISSION SYSTEMS AND MEDIA, DIGITAL SYSTEMS AND NETWORKS

Access networks – In premises networks

Narrowband orthogonal frequency division multiplexing power line communication transceivers for ITU-T G.hnem networks

Amendment 2: Clarifications on payload encoder and addition of a network admission procedure

Recommendation ITU-T G.9902 (2012) – Amendment 2

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Recommendation ITU-T G.9902

Narrowband orthogonal frequency division multiplexing power line communication transceivers for ITU-T G.hnem networks

Amendment 2

Clarifications on payload encoder and addition of a network admission procedure

Summary

Amendment 2 to Recommendation ITU-T G.9902 (2012) contains:

- Corrections and clarifications on the payload encoder;
- The addition of a network admission procedure based on Recommendation ITU-T G.9961.

History

Edition	Recommendation	Approval	Study Group
1.0	ITU-T G.9902	2012-10-29	15
1.1	ITU-T G.9902 (2012) Amd. 1	2013-03-16	15
1.2	ITU-T G.9902 (2012) Amd. 2	2013-08-29	15

FOREWORD

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The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

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In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Compliance with this Recommendation is voluntary. However, the Recommendation may contain certain mandatory provisions (to ensure, e.g., interoperability or applicability) and compliance with the Recommendation is achieved when all of these mandatory provisions are met. The words "shall" or some other obligatory language such as "must" and the negative equivalents are used to express requirements. The use of such words does not suggest that compliance with the Recommendation is required of any party.

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As of the date of approval of this Recommendation, ITU had received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementers are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database at http://www.itu.int/ITU-T/ipr/.

Recommendation ITU-T G.9902

Narrowband orthogonal frequency division multiplexing power line communication transceivers for ITU-T G.hnem networks

Amendment 2

Clarifications on payload encoder and addition of a network admission procedure

Modifications introduced by this amendment are shown in revision marks. Unchanged text is replaced by ellipsis (…). Some parts of unchanged text (clause numbers, etc.) may be kept to indicate the correct insertion points.

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2 References

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[ITU-T G.9961] Recommendation ITU-T G.9961 (2010), *Unified high-speed wire-line based home networking transceivers – Data link layer specification.*

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8.3.3 Payload encoder

The functional diagram of the payload encoder is presented in Figure 8-9. It contains an FEC encoder, an aggregation and fragmentation block (AF), a fragment repetition encoder (FRE) and an interleaver. The FRE is to support a robust communication mode (RCM) and is bypassed in the case of a normal mode of operation (no repetitions).

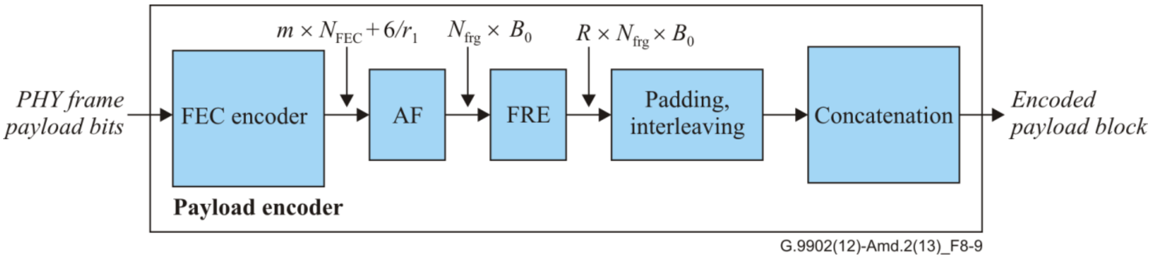

Figure 8-9 – Functional diagram of the payload encoder

The incoming PHY frame payload bits shall be divided into *m* sequential information blocks of K_l bytes per block, $l = 1, 2, ...m$, and each information block shall be encoded by the FEC encoder, as described in clause 8.3.2. The valid values of FEC parameters *K*, *R*, and r_I, and the coded block size N_{FEC} are presented in clause 8.3.2.3. The bytes in each information block shall be in the same order as they are in the corresponding MPDU.

The AF first collects the FEC codeword block of N_{FECB} bits generated by the FEC for the encoded payload. Furthermore, the FEC codeword block is partitioned into fragments of the same size B_0 bits each (e.g., $B_1 – B_4$ in Figure 8-10). The number of fragments is $N_{frg} = ceiling(N_{FECB}/B_0)$. To obtain an integer number of fragments, the FEC codeword block shall be padded with up to $B_P = B_0 \times N_{frg} – N_{FECB}$ bits.

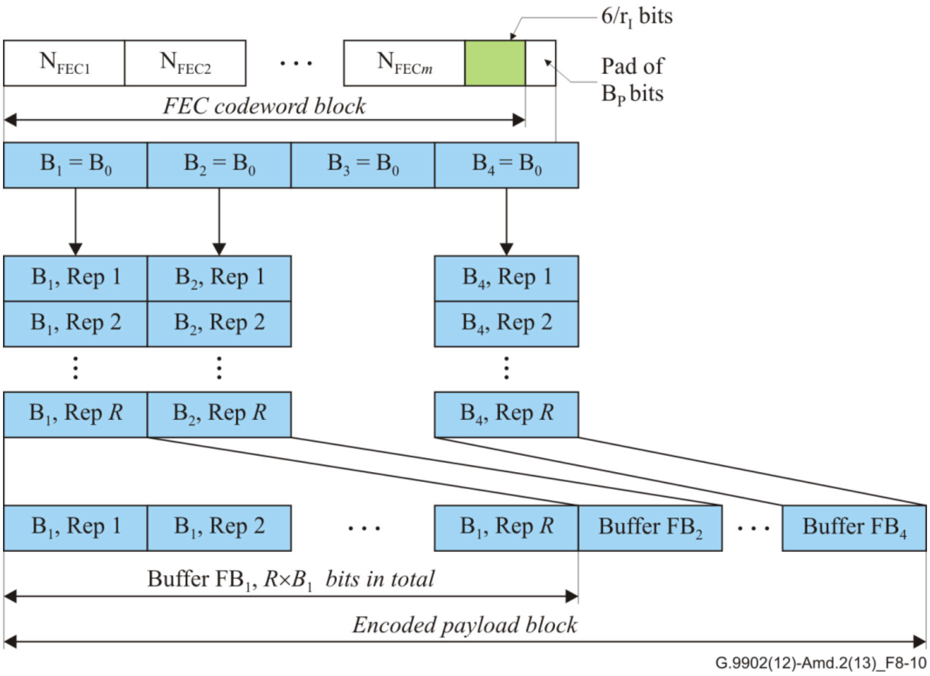

Figure 8-10 – Generation of the encoded payload block (case N_{frg} = 4, cyclic shifting, interleaving and padding of fragments when in IoAC mode is not shown)

The value of B_0 shall be calculated as an integer divisor of the total number of bits in the FEC codeword block and then increased to fit an integer number of symbols. This shall be the maximum divisor for which the value is less than or equal to the minimum of:

- the total number of input bits, N_{FECB}, in the FEC codeword block;
- the total number of bits, N_{ZC}, loaded on the symbols that span at least 10 ms for the case of 50 Hz AC lines, and at least 8.33 ms for the case of 60 Hz AC lines or lines with no AC;
- the maximum fragment size of B_{max} = 3072 bits.

The number of bits used to fit B_0 to an integer number of symbols shall not exceed the number of bits loaded onto a symbol (k_p) minus 1.

With the definitions above, the fragment size, B_0, and the number of pad bits, B_P, can be computed using the following steps:

- find the upper limit of the fragment size: $P= min(N_{FECB}, N_{ZC}, B_{max})$
- find the preliminary number of fragments: $N_{frg}' = ceiling(N_{FECB}/P)$
- find the fragment size: $B_0' = ceiling(N_{FECB}/N_{frg}')$; $B_0 = k_p \times ceiling\ (B_0'/ k_p)$
- find the final number of fragments: $N_{frg} = ceiling(N_{FECB}/B_0)$
- find the number of pad bits $B_P = B_0 \times N_{frg} – N_{FECB}$,

where k_p is the number of bits loaded onto a symbol. The pad bits, B_P, shall be generated by continuously extracting the MSB from the LFSR as shown in Figure 8-17 until the pad has filled up. The generation polynomial shall be as defined in clause 8.4.2.6. The LFSR initialization shall be all-ones as shown in Figure 8-17 prior to the first pad bit being extracted. The number of pad bits shall be less than $N_{frg} \times k_p$. Note that the actual B_0 size can be larger than P (by no more than k_p bits).

The FRE provides repetitions of fragments with the repetition rate of R. Each fragment shall be copied R times and all copies shall be concatenated into the fragment buffer, FB, so that the first bit of each copy follows the last bit of previous copy, see Figure 8-10. The total size of the FB is $B_0 \times R$ bits. The FRE shall support the values R = 1, 2, 4, 6, 12 (value of R = 1 corresponds to the normal mode of operation). If R = 1, an FB, accordingly, shall contain a single fragment of B_0 bits.

All fragments and their copies of each FB shall be interleaved. The interleaving method and parameters of the interleavers are defined in clause 8.3.5 and are the same for all valid values of R. Two modes of interleaving are defined:

- interleave-over-fragment (IoF)
- interleave-over-AC-cycle (IoAC).

The mode of interleaving is indicated in the PFH, as defined in clause 8.2.3.2.7 and shall be selected at the discretion of the transmitter. In both modes, for each fragment, prior to interleaving, the bits of each fragment copy starting from the second copy ("Rep 2" in Figure 8-10) shall be cyclically shifted by M = *ceiling* (B_0/R_T) bits relative to the previous copy in the direction from LSB to MSB, i.e., the copy "Rep(d+1)" shall be shifted by $d \times$ M bits relative to copy "Rep 1" so that the LSB of copy "Rep 1" will have bit number ($d \times$ M) in the copy "Rep(d+1)". The value of $R_T \geq R$ is the total number of repetitions, including padding; it depends on the mode of interleaving.

If the IoF mode is set, each fragment of the FB shall be interleaved separately. After the interleaving of all copies of the fragment, the FB shall be passed for concatenation. The value of R_T shall be set equal to R.

If the IoAC mode is set, each FB (containing R copies of the fragment) shall be padded to the closest integer number of symbols that is equal or more than the closest integer number of N_{ZC}, Figure 8-11. The pad shall be generated by cyclical repeating of the bits of this same FB, starting from its first bit: the first bit of the pad shall follow the last bit of the FB and shall be the repetition of the first bit of the same FB.

Furthermore, all copies of the fragment, both original and padded, shall be interleaved as defined in clause 8.3.5 for the payload interleaver. The total number of interleaved copies is RT = $ceiling(ceiling((B0 \times R)/N_{ZC}) \times N_{ZC}/B_0)$. ~~From the last copy, only the symbols that fill up the padded FB, as shown in Figure 8-11, shall be taken from the interleaver.~~ After interleaving of all copies of the fragment, the padded FB shall be passed for concatenation.

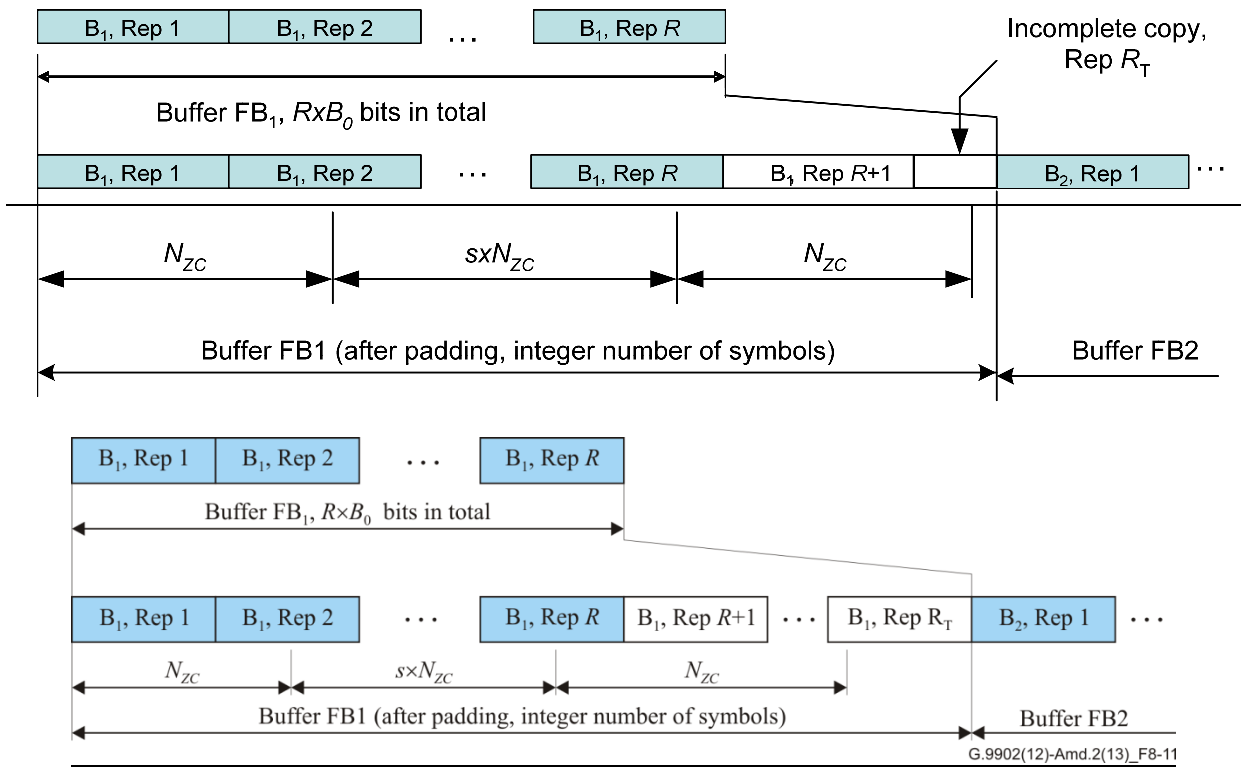

Figure 8-11 – Padding of the FB in IoAC mode

The FBs processed as described above shall be concatenated into an encoded payload block, in the order of the sourcing fragments, as shown in Figure 8-10.

The encoded payload block is passed for mapping into symbol frames (see clause 8.3.6).

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9 Data link layer (DLL) specification

In the present clause, the status of each requirement from the reference documents is given using the following convention:

- I = "Informative". The statements of the reference document are provided for information only.
- N = "Normative": The statements of the reference document shall apply without modifications or remarks.
- S = "Selection": The statements of the reference document shall apply with the selections specified.
- E = "Extension": The statements of the reference document shall apply with the extensions (modifications and remarks noted under the part title) specified.
- N/R = "Not Relevant": The statements of the reference document do not apply. An explanation may be given under the part title.

•••

9.5 Domain management protocols

9.5.1 Network admission~~Setup of a domain~~

The Authentication and key management procedures are specified in [ITU-T G.9961] using the selections and modifications listed in Table 9-34a.

Table 9-34a – Network admission selections from ITU-T G.9961

Clause number in ITU-T G.9961	Title and remarks/modifications	Statement
8.6.1	Network admission – MAP and MAP-D messages are not implemented in the current specification – The node shall wait for the beacon message when the domain operates in synchronous or asynchronous beacon mode, as described in clause 9.3.4. The node may start the admission protocol without waiting for beacon message when the domain is operating in beaconless mode – DEVICE_ID is replaced by NODE_ID and described in clause 9.3.1.2.2 of the current specification	S
8.6.1.1	Network admission protocol	N
8.6.1.1.1	Registration to the domain – MAP message are replaced by Beacon or skipped in beaconless mode – 1 second timeout is replaced with REG_RESP_TIME – ADM_NodeRegistRequest.req shall be sent with MA priority 2 – DEVICE_ID is replaced by NODE_ID and described in clause 9.3.1.2.2 of the current specification	S
8.6.1.1.2	Periodic re-registrations – MAP message are replaced by Beacon or skipped in beaconless mode – ADM_DmRegistrResponse.cnf message shall be sent with MA priority 2	S
8.6.1.1.3	Resignation from the domain	N
8.6.1.1.3.1	Self-resignation – 450 ms is replaced with RES_REQ_TIME – DEVICE_ID is replaced by NODE_ID and described in clause 9.3.1.2.2 of the current specification	S
8.6.1.1.3.2	Forced resignation – 200 ms is replaced with FORCED_RES_REQ_TIME	S
8.6.1.1.4	Registration and resignation messages	N
8.6.1.1.4.1	Registration request message	N

Table 9-34a – Network admission selections from ITU-T G.9961

Clause number in ITU-T G.9961	Title and remarks/modifications	Statement
8.6.1.1.4.2	Registration response message – DEVICE_ID is replaced by NODE_ID and described in clause 9.3.1.2.2 of the current specification. The field size id expanded to 16 bits – Bandplan field is not implemented – Security field is extended to 64 bits (16 bits for NODE_ID and 48 bits for REGID)	S
8.6.1.1.4.3	Resignation request message	N
8.6.1.1.4.4	Resignation confirmation message – DEVICE_ID is replaced by NODE_ID and described in clause 9.3.1.2.2 of the current specification. The field size id expanded to 16 bits	S
8.6.1.1.4.5	Forced resignation request message	N
8.6.1.2	Admission via proxy – MAP message are replaced by Beacon or skipped in beaconless mode	S

Domain in considered to be established if, and only if, there is a node operating as a domain master with a particular DOMAIN_ID. Therefore, to establish a domain the following has to be done:

– one of the nodes takes the role of the domain master;

– the domain master selects a DOMAIN_ID for its domain;

– all other nodes intended to be part of the established domain take a role of end-nodes and register into the domain.

Only one node in the domain may take the role of a domain master at any one time, while multiple nodes may be capable of operating as a domain master (DM-capable nodes). A domain master selection protocol defined in clause 9.5.1.1 shall be used to pick a single domain master in the presence of multiple DM-capable nodes.

Each domain is uniquely identified by its domain name which is set by the user or generated autonomously by the domain master that initializes the domain. Setup of the domain name is beyond the scope of this Recommendation. The domain name indicator (DNI) transmitted in the beacon frame indicates the domain name. The format of the DNI is defined in clause 9.5.1.3. Once generated, the DNI shall not change when the role of the domain master is passed to another node.

NOTE – The DNI is similar to SSID in 802.11 networks.

The domain master shall set a DOMAIN_ID for its domain using the DOMAIN_ID selection protocol defined in clause 9.5.1.2; this protocol provides, for a new-established domain, a value of DOMAIN_ID that is different from those in neighbouring domains.

9.5.1.1 Configurable parametersDomain master selection protocol

This is for further study.

The parameters that can be configured are listed in Table 9-34b.

Table 9-34b – Network admission selections from ITU-T G.9961

Parameter name	Default value	Description
REG_RESP_TIME	1 s	The registration response timeout in seconds
RES_REQ_TIME	1 s	The self-resignation request of the response timeout in seconds
FORCED_RES_REQ_TIME	1 s	The forced resignation request timeout in seconds

9.5.1.1.1 Domain master selection at initialization

This is for further study.

9.5.1.1.2 Domain master recovery if no backup domain master is assigned

This is for further study.

9.5.1.2 Domain ID selection protocol

This is for further study.

9.5.1.2.1 Domain ID conflicts detection

This is for further study.

9.5.1.2.2 Domain ID conflicts resolution

This is for further study.

9.5.1.3 Parameters of domain setup procedures

This is for further study.

9.5.2 Admission to the domain

The procedure of admitting a new node to the domain (also called "registration") is for further study.

9.5.3 Backup of the domain master

Assignment of a node to back up the domain master and the domain master backup procedures are for further study.

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9.6.2 Authentication and key management procedures

For further study

The Authentication and key management procedures are specified in [ITU-T G.9961] using the selections listed in Table 9-43.

Table 9-43 – Authentication and key management selections from ITU-T G.9961

Clause number in ITU-T G.9961	Title and remarks/modifications	Statement
9.2.1	Overview	N
9.2.2	Authentication to the domain	N
9.2.2.1	Authentication	N
9.2.2.1.1	Authentication via proxy	N
9.2.2.2	The PAK protocol parameters	N
9.2.2.2.1	Node Identifier	N
9.2.2.2.2	Node password	N
9.2.2.2.3	Diffie-Hellman prime	N
9.2.2.2.4	Diffie-Hellman generator	N
9.2.2.2.5	Secret exponents	N
9.2.2.2.6	Hush functions	N
9.2.2.2.7	NSC key	N
9.2.3	Pair-wise authentication and generation of point-to-point keys	N
9.2.3.1	Generation of point-to-point and point-to-multipoint encryption keys	N
9.2.4	Updating and termination of encryption keys	N
9.2.4.1	Updating of NSC and NN keys	N
9.2.4.2	Updating of NN keys	N
9.2.4.3	Termination of NSC and NN keys	N
9.2.4.4	Updating of the DB and NMK keys	N
9.2.5	Messages supporting AKM procedures	N
9.2.5.1	Authentication messages	N
9.2.5.1.1	Format of AUT_NodeRequest.req	N
9.2.5.1.2	Format of AUT_Promp.ind	N
9.2.5.1.3	Format of AUT_Verification.rsp	N
9.2.5.1.4	Format of AUT_Confirmation.cnf	N
9.2.5.2	Pair-wise authentication messages	N
9.2.5.2.1	Format of the AKM_KeyRequest.req	N
9.2.5.2.1.1	Format of the AKM_AddClient.req	N
9.2.5.2.2	Format of AKM_NewKey.req	N
9.2.5.2.3	Format of AKM_NewKey.cnf	N
9.2.5.2.4	Format of AKM_KeyConfirmation.req	N
9.2.5.2.5	Format of SC_DMRes.req	N
9.2.5.2.6	Format of SC_DMRes.cnf	N
9.2.5.2.7	Format of AKM_NewKey.ind	N
9.2.5.3	Key updating messages	N
9.2.5.3.1	Format of the AKM_KeyUpdate.req	N
9.2.5.3.2	Format of AKM_DomainKeyUpdate.ind	N

Table 9-43 – Authentication and key management selections from ITU-T G.9961

Clause number in ITU-T G.9961	Title and remarks/modifications	Statement
9.2.5.3.3	Format of AKM_DomainKeyUpdate.req message	N
9.2.5.3.4	Format of AKM_DomainKeyUpdate.cnf message	N

…

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