Smart Grid Standards Information

Version 1.6
Monday, May 10, 2010

Section I: Use and Application of the Standard

A. Identification and Affiliation

1.	Number of the standard	C37.118 - 2005
2.	Title of the standard	IEEE Standard for Synchrophasors for Power Systems
3.	Name of owner organization	IEEE
4.	Latest versions, stages, dates	• Latest version – 2005 • Status – PAR is approved and Working Group is in the process of updating and revising the standard
5.	URL(s) for the standard	http://ieeexplore.ieee.org/xpl/standards.jsp
6.	Working group / committee	IEEE Power System Relay Committee
7.	Original source of the content (if applicable)	IEEE 1344-1995 (reaffirmed in 2001)
8.	Brief description of scope	This is a standard for synchronized phasor measurement systems in power systems. It addresses the definition of a synchronized phasor, time synchronization, application of timetags, method to verify measurement compliance with the standard, and message formats for communication with a phasor measurement unit (PMU). In this context, a PMU can be a stand-alone physical unit or a functional unit within another physical unit. This standard does not specify limits to measurement response time, accuracy under transient conditions, hardware, software, or a method for computing phasors. (Source: IEEE C37.118-2005 – Scope Statement)

B. Level of Standardization

9.	Names of standards development organizations that recognize this standard and/or accredit the owner organization	It is anticipated that the IEC will recognize (and/or dual logo with the IEEE) the phasor measurement aspects of the current standard once this content is published separately from the communications content.
10.	Has this standard been adopted in regulation or legislation, or is it under consideration for adoption?	☐ Yes ☒ No

Section I: Use and Application of the Standard

11.	Has it been endorsed or recommended by any level of government? If "Yes", please describe	☒ Yes ☐ No NIST has identified IEEE C37.118-2005 in its initial release of Smart Grid interoperability standards. Refer to the NIST Framework and Roadmap for Smart Grid Interoperability Standards, Release 1.0 (January 2010).
12.	Level of Standard (check all that apply)	☒International ☐National ☐Industry ☐de Facto ☐ Single Company
13.	Type of document	☒Standard ☐ Report ☐ Guide ☐ Technical Specification
14.	Level of Release	☒ Released ☐ In Development ☐ Proposed

C. Areas of Use

1.	Currently used in which domains? (check all that apply)	☐ Markets ☒ Operations ☐ Service Providers ☒ Generation ☒ Transmission ☐ Distribution ☐ Customer
2.	Planned for use in which domains? (check all that apply)	☐ Markets ☒ Operations ☒Service Providers ☒ Generation ☒ Transmission ☒ Distribution ☐ Customer
3.	Please describe the Smart Grid systems and equipment to which this standard is applied	This standard applies to devices that measure, derive and communicate synchronized phasor measurement data. The devices may be dedicated the purpose of phasor measurement or may be device that perform this function along with other functions such as protection.

D. Relationship to Other Standards or Specifications

1.	Which standards or specifications are referenced by this standard?	IEEE 1344-1995
2.	Which standards or specifications are related to this standard?	IEEE 1588 IEEE PC37.238
3.	Which standards or specifications cover similar areas (may overlap)?	None
4.	What activities are building on this work?	IEC 61850-90-5 – Technical Report on the Profile for Synchrophasor Data.

E. Dept of Energy Smart Grid Characteristics

Please describe how this standard may encourage each of the following:

1.	Enables informed participation by customers	☐ Yes ☒ No #####
2.	Accommodates all generation and storage options	☒ Yes ☐ No #####

Section I: Use and Application of the Standard		
3.	Enables new products, services and markets	☒ Yes ☐ No #####
4.	Provides the power quality for a range of needs	☒ Yes ☐ No #####
5.	Optimizes asset utilization and operating efficiency	☒ Yes ☐ No #####
6.	Operates resiliently to disturbances, attacks, and natural disasters	☒ Yes ☐ No #####

F. Priority Areas Previously Mentioned by FERC and NIST

Please describe if and how this standard may be applied in each of the following areas. Note that there is space in section J to discuss any other significant areas where the standard may be applied.

1.	Cybersecurity and physical security	☐ Yes ☒ No #####
2.	Communicating and coordinating across inter-system interfaces	☒ Yes ☐ No #####
3.	Wide area situational awareness	☒ Yes ☐ No #####
4.	Smart grid-enabled response for energy demand	☒ Yes ☐ No #####
5.	Electric storage	☒ Yes ☐ No #####
6.	Electric vehicle transportation	☐ Yes ☒ No #####
7.	Advanced metering infrastructure	☐ Yes ☒ No #####
8.	Distribution grid management	☒ Yes ☐ No #####

G. Openness

1.	Amount of fee (if any) for the documentation	#####IEEE Standard purchase cost.
2.	Amount of fee (if any) for implementing the standard	#####None
3.	Amount of fee (if any) to participate in updating the standard	#####None
4.	Is the standard documentation available online?	☒Yes ☐ No ##### URL: http://ieeexplore.ieee.org/xpl/standards.jsp
5.	Are there open-source or reference implementations?	☐ Yes ☒ No
6.	Are there open-source test tools?	☐ Yes ☒ No (TVA PMU Connection Test tool, BPA, EPG and others have tools that are not open source).
7.	Would open-source implementations be permitted?	☒ Yes ☐ No
8.	Approximately how many implementers are there?	In terms of devices and applications (US): PMUs and related – 15 PDCs – 5 Applications – 15-20 Total of approximately: 40 companies
9.	Approximately how many users are there?	#####In terms of utility companies in the US that use phasor data – 50 to 75
10.	Where is the standard used outside of the USA?	#####Every country except China (not confirmed regarding Russia)
11.	Is the standard free of references to patented technology?	☒ Yes ☐ No
12.	If patented technology is used, does the holder provide a royalty-free license to users of the standard?	☐ Yes ☐ No ☒ Not Patented See question 11, patented technology is not required to implement the standard however could be used.
13.	Can an implementer use the standard without signing a license agreement?	☒ Yes ☐ No
14.	Are draft documents available to the public at no cost?	☒ Yes ☐ No
15.	How does one join the working group or committee that controls the standard?	#####Contact Ken Martin WG-H11 Chair or the IEEE PSRC, Miriam Sanders, Chair
16.	Is voting used to decide whether to modify the standard? If Yes, explain who is permitted to vote.	☒ Yes ☐ No #####To vote, you must sign up to join the balloting group as an IEEE Standards Association member.
17.	Is an ANSI-accredited process used to develop the standard?	☒ Yes ☐ No Follows IEEE Standards Association processes.
18.	What countries are represented in the working group or committee that controls the standard?	#####Currently, US, Canada, Germany are the countries primarily represented. There are a large number of international participants as well.

H. Support, Conformance, Certification and Testing

1.	Is there a users group or manufacturers group to support this standard?	☐ Yes ☒ No However, a website is maintained by the Working Group to support users.

2.	What is the name of the users group or manufacturers group (if any)?	#####Not applicable
3.	What type of test procedures are used to test this standard? (please check all that apply)	☐ Internal to the lab ☐ Published by standards organization ☒ Published by users group (NASPI) ☐ No procedures, informal testing
4.	Are there test vectors (pre-prepared data) used in testing? (please check all that apply)	☐ Internal to the lab ☐ Published by standards organization ☐ Published by users group ☒ No procedures, informal testing
5.	What types of testing programs exist? (check all that apply)	☒ Interoperability Testing (BPA and NIST have created test programs) ☐ Conformance Testing ☐ Security Testing ☐ No Testing
6.	What types of certificates are issued? (check all that apply)	☐ Interoperability Certificate ☐ Conformance Certificate ☐ Security Certificate (text document) ☒ No Certificates (efforts are underway to establish a world wide certification program)
7.	Are there rules controlling how and when to use the logo?	☐ Yes ☐ No ☒ Standard has no logo
8.	Is there a program to approve test labs?	☐ Yes ☒ No (see note on item 6)
9.	Approximately how many test labs are approved (if any)?	#####Not applicable
10.	Is there a defined process for users to make technical comments on the standard or propose changes to the standard and have these issues resolved?	☒ Yes ☐ No Informal – direct contact with Working Group members. Formal procedure with the IEEE Standards Association or the IEEE PSRC
11.	Is there a published conformance checklist or table?	☐ Yes ☒ No
12.	Are there defined conformance blocks or subsets?	☐ Yes ☒ No
13.	Approximately how many vendors provide test tools?	#####Some test tools do exist such as those from BPA and NIST. Fluke has received an ARRA grant to develop a calibrator.
14.	Are there tools for pre-certification prior to testing?	☒ Yes ☐ No
15.	Can vendors self-certify their implementations?	☐ Yes ☒ No
16.	Is there application testing for specific uses?	☐ Yes ☒ No ☐ Not applicable
17.	Is there a “golden” or “reference” implementation to test against?	☐ Yes ☒ No
18.	Who typically funds the testing? (check all that apply)	☒ User ☐ Users Group ☒ Vendors ☐ Confidential
19.	Is there a method for users and implementers to ask questions about the standard and have them answered? (check all that apply)	☒ Yes, official interpretations ☒ Yes, informal opinions ☐ No

20.	Does the users' group (or some other group) fund specific tasks in the evolution of the standard?	☐ Yes ☒ No
21.	Is the users' group working on integration, harmonization or unification with other similar standards?	☒ Yes ☐ No
22.	What other standards is this standard being integrated, harmonized, or unified with (if any)?	#####IEC 61850 (Technical report 90-5)
23.	Are there application notes, implementation agreements, or guidelines available describing specific uses of the standard?	☒ Yes ☐ No ☐ Not applicable NASPI, large numbers of public domain papers.

J. Notes

Please present here any additional information about the standard that might be useful:

1.	The synchrophasor standard, C37.118, was first published in 2005. Although taken from the earlier standard, IEEE1344, it was essentially new, so there were no implementations. In the 5 years since its publication there has been rapid development of synchrophasor systems and a large number of new products introduced to the market. As a result of this, measurement and system operational requirements are much better understood. This has led to a revision of the C37.118 standard and efforts to harmonize it with other standards, such as IEC 61850. It has also pointed to the need for a greater infrastructure, such as measurement assurance agreement among entities that test PMUs for compliance and user groups that coordinate and disseminate information for unit and systems practices. The new standards will provide the needed requirements for measurement performance and communication interoperability. Information sharing is being developed by NASPI and cooperation among vendors. These things are not formally in place so are not represented in the Q-A of this survey. The community is aware of these needs and is responding.

Section II: Functional Description of the Standard

K. GridWise Architecture: Layers

Please identify which layers this standard specifies, as described in http://www.gridwiseac.org/pdfs/interopframework_v1_1.pdf, and the applicable section of the standard. Note the mapping to the Open Systems Interconnect (OSI) model is approximate.

1.	**Layer 8: Policy**	☐ Yes ☒ No #####
2.	**Layer 7: Business Objectives**	☐ Yes ☒ No #####
3.	**Layer 6: Business Procedures**	☐ Yes ☒ No #####
4.	**Layer 5: Business Context**	☐ Yes ☒ No #####
5.	**Layer 4: Semantic Understanding (object model)**	☐ Yes ☒ No #####
6.	**Layer 3: Syntactic Interoperability (OSI layers 5-7)**	☐ Yes ☒ No #####
7.	**Layer 2: Network Interoperability (OSI layers 3-4)**	☒ Yes ☐ No #####
8.	**Layer 1: Basic Connectivity (OSI layers 1-2)**	☒ Yes ☐ No #####

L. GridWise Architecture: Cross-Cutting Issues

Please provide an explanation in the box beside the heading for any questions answered "Not applicable". If the question is not applicable because the function is provided in another layer or standard, please suggest any likely candidates. Note that "the standard" refers to the technology specified by the standard, not the documents themselves.

	Shared Meaning of Content	C37.118 does not specify any modeling. The user can apply any method they like.
1.	Do all implementations share a common information model?	☐ Yes ☐ No ☒ Not applicable
2.	Can data be arranged and accessed in groups or structures?	☐ Yes ☐ No ☒ Not applicable
3.	Can implementers extend the information model?	☐ Yes ☐ No ☒ Not applicable
4.	Can implementers use a subset of the information model?	☐ Yes ☐ No ☒ Not applicable
	Resource Identification	Naming is provided in 16 character fields. The content of the field is user specified.
5.	Can data be located using human-readable names?	☒ Yes ☐ No ☐ Not applicable
6.	Can names and addresses be centrally managed without human intervention?	☒ Yes ☐ No ☐ Not applicable
	Time Synchronization and Sequencing	C37.118 does not specify how time will be provided. It only specifies the minimum timing precision through the measurement.
7.	Can the standard remotely synchronize time?	☒ Yes ☐ No ☐ Provided in another layer
8.	Can the standard indicate the quality of timestamps?	☒ Yes ☐ No ☐ Provided in another layer

Section II: Functional Description of the Standard		
	Security and Privacy	C37.118 provides data communication content and message format only. It is intended for application level interface. Other aspects are provided by the communication protocol.
9.	Where is security provided for this standard?	☐ Within this standard ☒ By other standards
10.	Does the standard provide authentication?	☐ Yes ☒ No See 9
11.	Does the standard permit role-based access control?	☐ Yes ☒ No See 9
12.	Does the standard provide encryption?	☐ Yes ☒ No See 9
13.	Does the standard detect intrusions or attacks?	☐ Yes ☒ No See 9
14.	Does the standard facilitate logging and auditing of security events?	☐ Yes ☒ No See 9
15.	Can the security credentials be upgraded remotely?	☐ Yes ☒ No ☐ No Credentials See 9
16.	Can the security credentials be managed centrally?	☐ Yes ☒ No ☐ No Credentials See 9
17.	Please list any security algorithms and standards used	Security, if any, is provided by the communication protocol.
18.	Please provide additional information on how the standard addresses any “Yes” answers above	No yes’s
19.	Please provide additional information about why any of the questions listed above do not apply to this standard	See 9
	Logging and Auditing	C37.118 does not cover communications or user applications. It does not cover any logging or auditing within the range of its requirements.
20.	Does the standard facilitate logging and auditing of critical operations and events?	☐ Yes ☒ No
21.	Can the standard gather statistics on its operation?	☐ Yes ☒ No ☐ Not applicable
22.	Can the standard report alerts and warnings?	☐ Yes ☒ No ☐ Not applicable
	Transaction State Management	C37.118 allows controlling the data flow and remote acquiring configuration information
23.	Can the standard remotely enable or disable devices or functions?	☒ Yes ☐ No ☐ Not applicable
	System Preservation	C37.118 does not cover communications protocols or functions
24.	Can the standard automatically recover from failed devices or links?	☐ Yes ☐ No ☐ Not applicable ☒ Provided in another layer
25.	Can the standard automatically re-route messages?	☐ Yes ☐ No ☐ Not applicable ☒ Provided in another layer
26.	Can the standard remotely determine the health (as opposed to just connectivity) of devices or software?	☒ Yes ☐ No ☐ Not applicable
	Other Management Capabilities	

Section II: Functional Description of the Standard		
27.	Please describe any other system or network management capabilities the standard provides.	C37.118 does not cover communications protocol issues
	Quality of Service	C37.118 does not cover communications protocol considerations
28.	Is data transfer bi-directional?	☐ Yes ☒ No
29.	Can data be prioritized?	☐ Yes ☐ No ☒ Not applicable
30.	What types of reliability are provided?	☐ Reliable ☐ Non-guaranteed ☐ Both ☐ Either ☒ Provided in another layer
31.	Can information be broadcast to many locations with a single transmission?	☒ Yes ☐ No ☐ Not applicable
32.	Please describe any other methods the standard uses to manage quality of service.	C37.118 does not cover communications protocol issues
	Discovery and Configuration	C37.118 does not cover communications protocol or vendor specific issues
33.	Can the software or firmware be upgraded remotely?	☐ Yes ☐ No ☒ Not applicable
34.	Can configuration or settings be upgraded remotely?	☐ Yes ☐ No ☒ Not applicable
35.	Can implementations announce when they have joined the system?	☐ Yes ☐ No ☒ Not applicable
36.	Can implementations electronically describe the data they provide?	☒ Yes ☐ No ☐ Not applicable
	System Evolution and Scalability	C37.118 covers both the measurement and data communication format. The measurement is specified by limit requirements rather than an algorithm, so it does not limit advances in technology. Data communication format is specified, so any protocol can be used. It should be easy to adopt other formats following the guidelines established by the given methods.
37.	What factors could limit the number of places the standard could be applied?	C37.118 can be used for any synchrophasor measurement. The data communication could be used with any real-time data reporting for sampled data, but the measurement is only applicable for AC measurements.
38.	What steps are required to increase the size of a system deploying this standard?	At the measurement end, signal input to the measurement devices. At the reporting side, communication capability and application processing capability must be espanded.
39.	Is the information model separate from the transport method?	☒ Yes ☐ No
40.	Does the standard support alternate choices in the layers(s) below it?	☒ Yes ☐ No ☐ No layers below

Section II: Functional Description of the Standard		
41.	List the most common technology choices for layers implemented below this standard	Direct interface into IP communication is widely described and supported.
42.	Does the standard support multiple technology choices in the layers above it?	☒ Yes ☐ No ☐ No layers above
43.	List the technologies or entities that would most commonly use this standard in the layer above	Communication related technology including DNP-3, ICCP, IP, RS-232, OPC, and possibly IEC 61850
44.	Please describe any mechanism or plan to ensure the standard is as backward-compatible as possible with previous versions	The standard is updated periodically as required by an IEEE Working Group. It is up to the WG to assure that compatibility is achieved with previous versions and other standards.
45.	Please describe how the design of this standard permits it to be used together with older or legacy technologies	This standard uses the same basic definition and communication method as original technology and succeeds IEEE 1344, the only previous standard. C37.118 does add performance requirements which may not be met by legacy equipment.
46.	Please describe how the design of this standard permits it to co-exist on the same network or in the same geographic area with similar technologies, and give examples	C37.118 can use any basic communication protocol and coexistence is determined by that choice. For example, if TCP/IP is chosen, that can use the same network as DNP3 or 61850. It can also be used in the same geographic area as a Relay or DFR which may record the same signals from the same sensing devices.
47.	**Electromechanical**	There are no electromechanical aspects to this standard

M. Architectural Principles

Please describe how this standard may apply any of these principles:

1.	Symmetry – facilitates bi-directional flow of energy and information	C37.118 is a measurement standard; the direction of energy flow is irrelevant. Information basically flows from the measuring device to the user; data flow back to the measurement is for control of the data flow only.
2.	Transparency – supports a transparent and auditable chain of transactions	The transaction chain has limited transparency. Supplemental information such as intermediate processing needs separate documentation.
3.	Composition – facilitates the building of complex interfaces from simpler ones	The C37.118 protocol is designed to simplify aggregation and de-aggregation. The data transfer specification does not restrict its use to a specific protocol, so it is highly adaptable.

Section II: Functional Description of the Standard		
4.	Loose coupling – can support bilateral and multilateral transactions without elaborate pre-arrangement	Data transfer with C37.118 can be done with simple or complex protocols. Users and employ any protocol they like to accomplish the coupling most appropriate to their needs.
5.	Shallow integration – does not require detailed mutual information to interact with other components	As in previous questions, the level of integration depends on the chosen protocol.
6.	Please list any other architectural models, reference architectures or frameworks this standard was designed to be compliant with, e.g. W3C, IEC TC57, OSI and how it fits those models	C37.118 specifies data content and format for data transfer. This maintains the relationship between data items as it is reported to an application. It interacts with communications at the application level in the OSI model. Any other complete protocol that preserves the data quality and these relationships can be used for synchrophasor data communication.