NASPI North American SynchroPhasor Initiative

Synchrophasor Standards and Guides

PSTT and IEEE PSRC

Vahid Madani, Ken Martin, and Damir Novosel

NASPI General Meeting

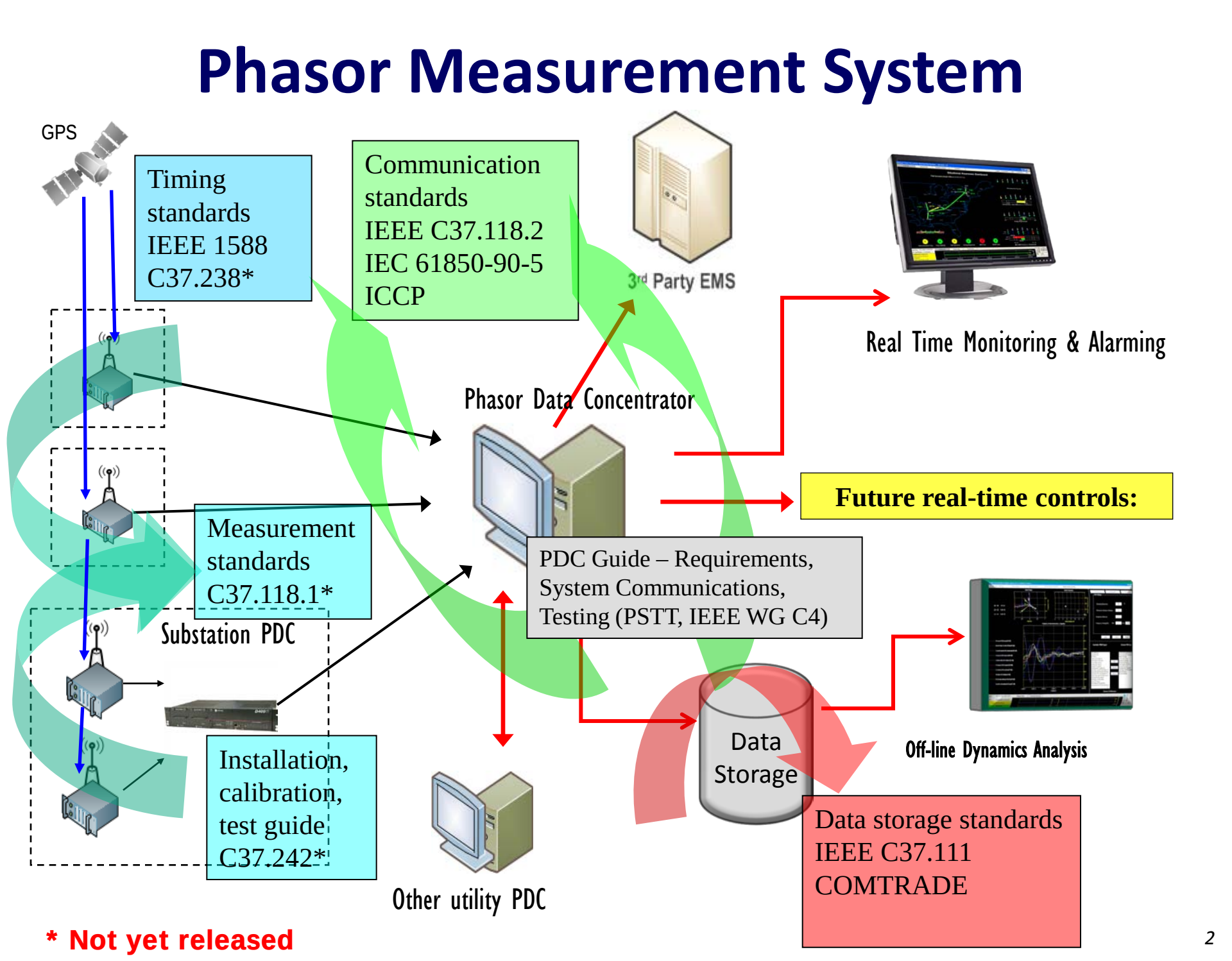
February 23, 2011

Ft. Worth, TX

Presentation

- **Standards & guides related to synchrophasors**
- **Addressing interoperability issues**
- **Development outlook**

Phasor Measurement System



* Not yet released

Brief History of Synchrophasor related Standards & Guides

- IEEE 1344 synchrophasor standard in 1995
  - Time sync defined by sample timing
  - No measurement requirements
- IEEE C37.118-2005 in 2005
  - Total Vector Error (TVE) method for measurement qualification
  - Requirements for steady-state performance
  - Extended data communication profile
- Revision of C37.118 started in 2008
  - Dynamic & frequency requirements, communication improvements
- 1588 timing profile & COMTRADE profile in 2008
- Synchrophasor additions to 61850 started in 2009
- PSTT Testing, Calibration, and Installation guides in 2008 – IEEE PC37.242 started in 2010
- PDC Guide started in 2009 by NASPI / PSTT
  - Expected Completion April 2011
    - Plans are in place to generate IEEE Guide

Synchrophasor Measurement Standard IEEE C37.118.1

- IEEE standard PC37.118.1 covers measurement of and requirements for synchrophasors, frequency, & rate of change of frequency (ROCOF)
  - Adds dynamic measurement requirements to present steady-state
  - Adds requirements for frequency measurements
- Specifies an measurement evaluation method (TVE, FR, & RFE)
- Specifies conditions or tests for measurement evaluation
- Provides evaluation error limits
- Adds annex with sample algorithms
  - Supports requirement development & aids user implementation
- *PMUs that meet the Standard should provide comparable measurements under most power system operating conditions*

IEEE C37.118.1 Outlook

- All development of formulas, tests, & algorithms complete
- Expected to go to IEEE ballot in March 2011
- Final approval in June & publication in July, 2011

- Most current PMU equipment will meet 37.118.1 requirements
  - To be confirmed by test
  - Small measurement differences with C37.118-2005 compliant equipment
  - A crossover list should be prepared so users can note differences
- *Fully compliant PMUs expected within 6 months of final approval*
- A joint IEEE-IEC synchrophasor measurement standard based on IEEE C37.118.1 is proposed - IEC 95-277

Synchrophasor Data Transfer Standard IEEE C37.118.2

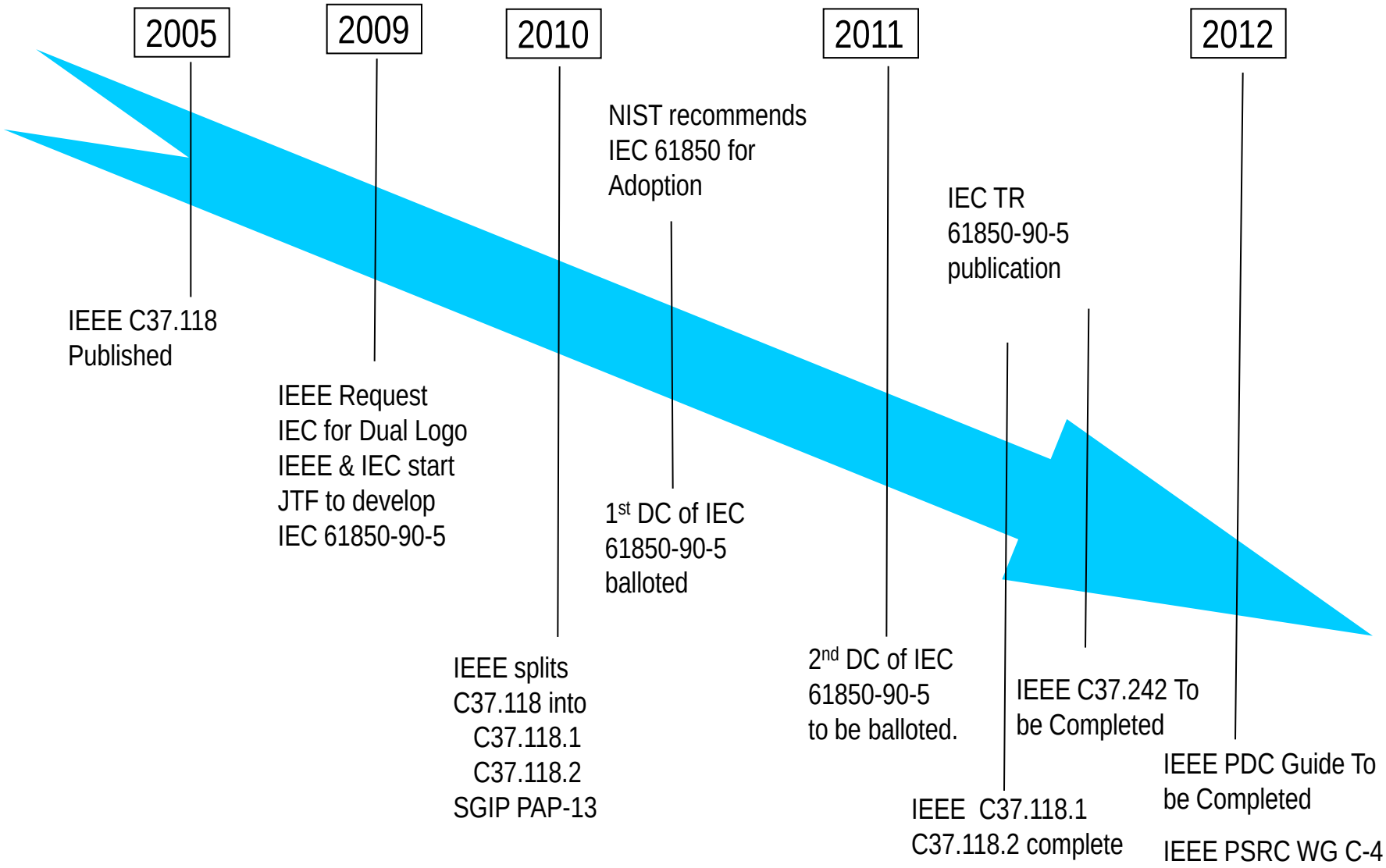
- Covers the communication of phasor measurements
  - Describes simple and compact messaging structure and contents
  - Includes a simple command-response for essential parameters
  - Can use any communication protocol or hardware
- Standard practice is established by industry
  - Common mapping onto IP protocol, Ethernet, RS232, other protocols
  - Security can be applied appropriate to selected protocol
- Improved configuration message added: Flexible naming; Extended scaling parameters; Additional data (e.g. geographic location)
- Time Quality for measurements added
- Improved data modification flagging
- *All changes fully backward compatible with C37.118-2005*

IEEE C37.118.2 Outlook

- Most development is complete
- Expected to go to IEEE ballot in March 2011
- Publication in July 2011

- *All current C37.118-2005 compliant equipment will meet 37.118.2 requirements*
  - *-2005 equipment interoperable without new features*
- *Fully compliant PMUs could be available 6-12 months after publication*

Project Timeline: Simplified



IEC 61850 Synchrophasor -90-5

- 61850 is the IEC standard for communication between IEDs
- New development for synchrophasors using 61850 standard
- Significant additions
  - Draws on wide range of use cases, analysis to protection
  - Adds routability to sampled values (using UDP, called R-SV)
  - Modeling is extended to the PDC function
  - Substation configuration language (SCL) is likewise extended
  - Uses MMXU logical node for basic measurements (I, V, P, Q, F, etc.)
  - Use Sequence components
  - A new security method for multicast encryption
- Security in Multicast - Allows key management based upon “stream”, allows PMU/PDC to act as own Key manager
- Gives preference to multicast UDP - Applications can perform time alignment function
  - C 37.118 Does not require time alignment for PDC

IEC 61850-90-5 outlook

- First complete draft in August 2010
- Meeting at end of February to resolve current draft
- Publication in August 2011

- Use of 61850 requires sending & receiving 61850 compatible equipment
- Adoption depends on user advantages
- Measuring type equipment could be available 6-24 months after publication
- Software type processing equipment (PDCs, etc.) could be available 3-6 months after publication

IEC 61850-90-5 Advantages

- Leverages world-wide interoperability effort of devices and systems in power systems communications including:
  - Hierarchical Object model structure allows one time modeling for enterprise applications
  - Standardized modeling and services
    - Implication of a growing pain – Benefits outweigh the upfront work
  - Established high speed data services for protection and control
  - Automated system engineering tools and processes
  - Testing, verification, and quality assurance processes
- Easier to support and maintain by end user
  - PMU models and functions are integrated with the rest of the substation and system functions configured by 61850 automated processes – reduced manual configuration
  - Consistent with other 61850 substation IED communications stacks and services
  - Leverages available 61850 tools and processes

Guide for Synchronization, Testing, Calibration and Installation of PMUs IEEE C37.242*

- IEEE Guide is a combination of NASPI PSTT documents
  - Test and calibration for laboratory and field applications: Updated to comply with 37.118 improvements
  - Installation of PMU devices based on application requirements and typical bus configurations
  - Techniques focusing on the overall accuracy and availability of the time synchronization system
  - System testing and calibration

- Started in 2010 on the fast track
- Initial ballots May & September 2011
- Final release expected by December 2011
- Help users with interoperability testing and installations, starting January 2012

*** Not yet released**

PSTT PDC Guide

- NIST supported PSTT work on Fast Track
  - PDC Functional Requirements Guide
  - Synchrophasor System Communications Guide
  - PDC Test Guide
- Support both IEEE C37.118.2 and IEC 61850-90-5
  - Concurrent identification of gaps and solutions to improve standards near completion

	First draft	PSTT review calls	PSTT Review at NASPI	Revised Draft	Available for IEEE
PDC Functional Requirements Guide	1/2011	1/2011	**2/23/1011**	3/2011	5/2011
Synchrophasor System Communications Guide	2/2011	2/2011	**2/23/1011**	4/2011	5/2011
PDC Test Guide	2/2011	3/2011	**2/23/1011**	5/2011	5/2011

PDC Functional Requirements Guide

- Identified major PDC functional requirements
  - Time alignment:
    - Wait Time
    - Buffer Time
    - Data Processing Time
  - Data re-sampling and filtering issues and impact on accuracy
  - Data validation
- Non-core functions in Appendices:
  - Data storage
  - Event detection
  - Gateway
- *PSTT Review Meetings on 1/21/2011 and 1/28/2011*

Synchrophasor System Communications Guide

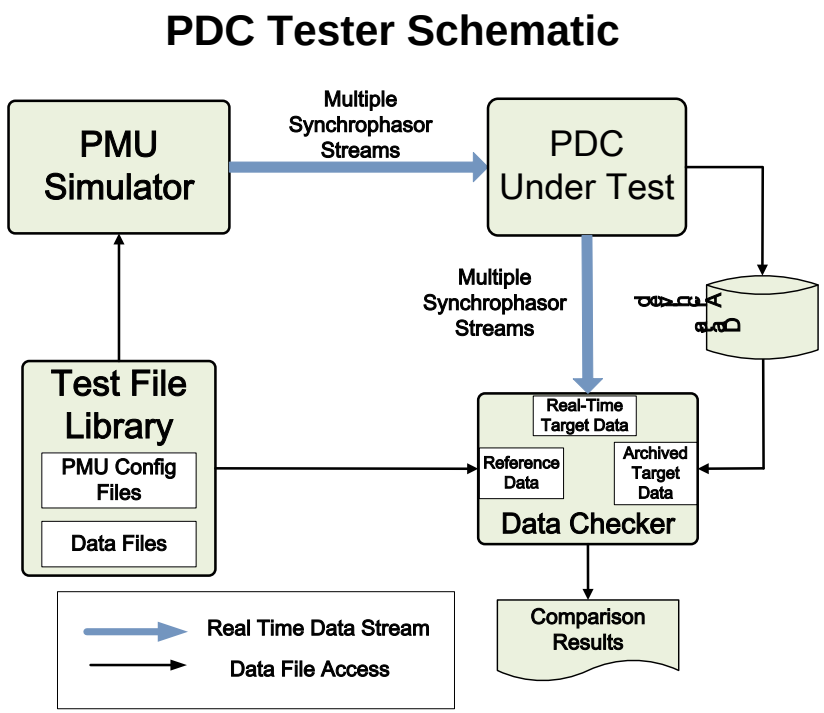
- Identified Major Communication Needs of Synchrophasor Systems
  - Data Flow Management
    - Late, lost, and missing data
    - Data quality marking
  - System Configuration Management
    - Addition / removal of devices / signals
    - Automatic Reconnection
    - Hierarchical Configuration
    - Addition of Application functions

- *PSTT Review Meetings on 2/11/2011 and 2/18/2011*
- *Further coordination with Data Network Management (DNMTT)*

PDC Testing Guide

Driven by PDC Functional Requirements and Synchrophasor System Communication Requirements

- First draft focus on test techniques to verify core Functional Requirements
  - Merging time-aligned data
  - Timing measurements
  - Capacity limitations/ determination
  - Comparative measurements (using a reference PDC)
    - Timing
    - Data quality
    - Impact of filtering
    - Impact of data volume (both input and output)



- Final document includes Synchrophasor Communication Req.

PDC Guide Outlook

- Publication of NIST supported PSTT PDC Guides in May 2011
- Available to vendors and users
- Support both IEEE C37.118.2 and IEC 61850-90-5

- Hand-off to IEEE (PSRC WG C4) - PDC Guide for fast track development – Starts May 2011
- Initial balloting – January 2012
- Publication in May 2012
- Compliant PDCs and Systems could be available beginning of 2012

Use of IEEE 1588 PTP in Power Systems, Standard IEEE C37.238

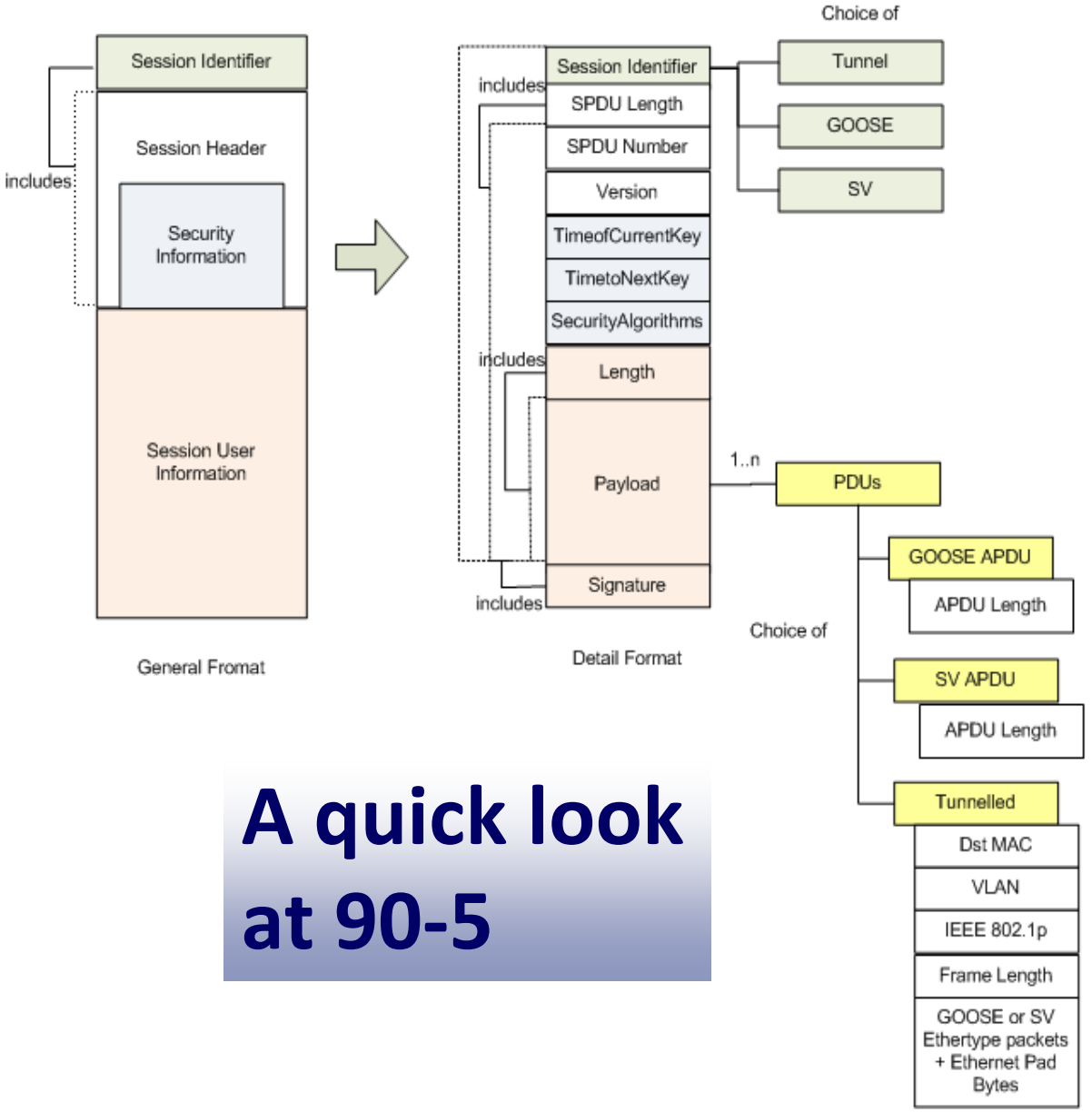
- IEEE 1588 (IEEE C 37.238) describes a Precision Time Protocol for transferring precise time over Ethernet
  - It includes many parameters that need to be mapped to specific applications
- New IEEE C37.238 describes mappings for power systems applications

- Balloted in 2010 and comments have been resolved
- Final ballot expected by end of February 2011
- Standard approved by June 2011
- Fully compliant clocks could be available 3-6 months after publication
- Compliant PMUs could be available within 1-2 years

References and Informational Material

- Technical Presentations on Thursday
- IEC 61850-90-5 Basics -- what's new, what does it mean for future systems and devices, what does it mean for legacy systems and devices?
- Contacts:
  - IEEE C-37.118 Ken Martin - martin@electricpowergroup.com
  - IEEE 1588 Galina Antonova - galina.s.antonova@ca.abb.com
  - IEC 61850 Alex Apostolov - alex.apostolov@omicronusa.com
  - PSTT Material Vahid Madani – vxm6@pge.com
  - PSTT Guides Damir Novosel - DNovosel@Quanta-Technology.com
  - SGIG (i.e: PAP 13) Ron Farquharson - Ron@ENERNEX.COM

Questions and Discussion??



A quick look at 90-5