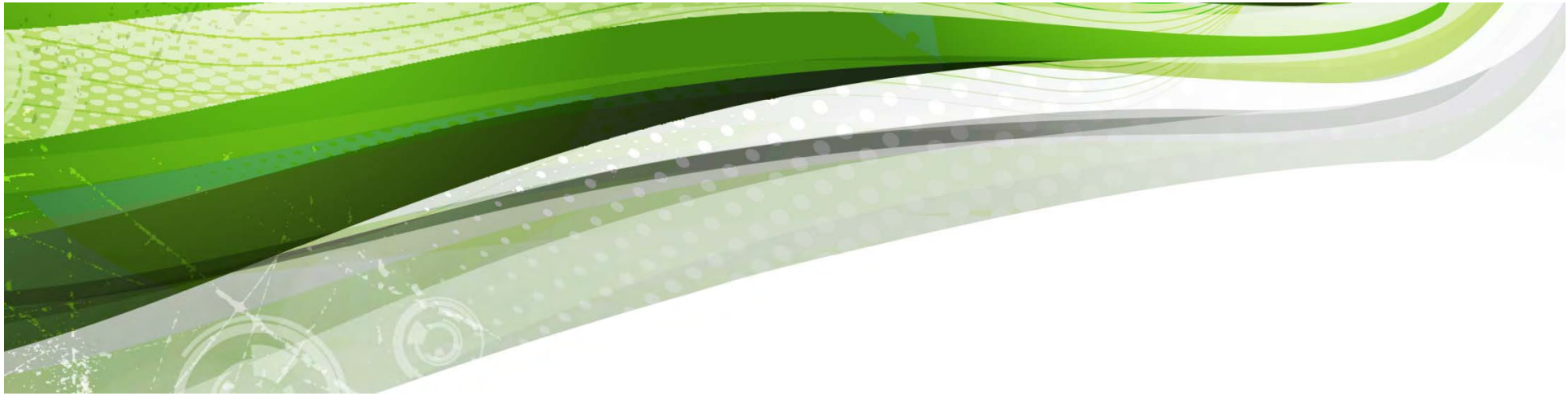
OSGP - Open Smart Grid Protocol

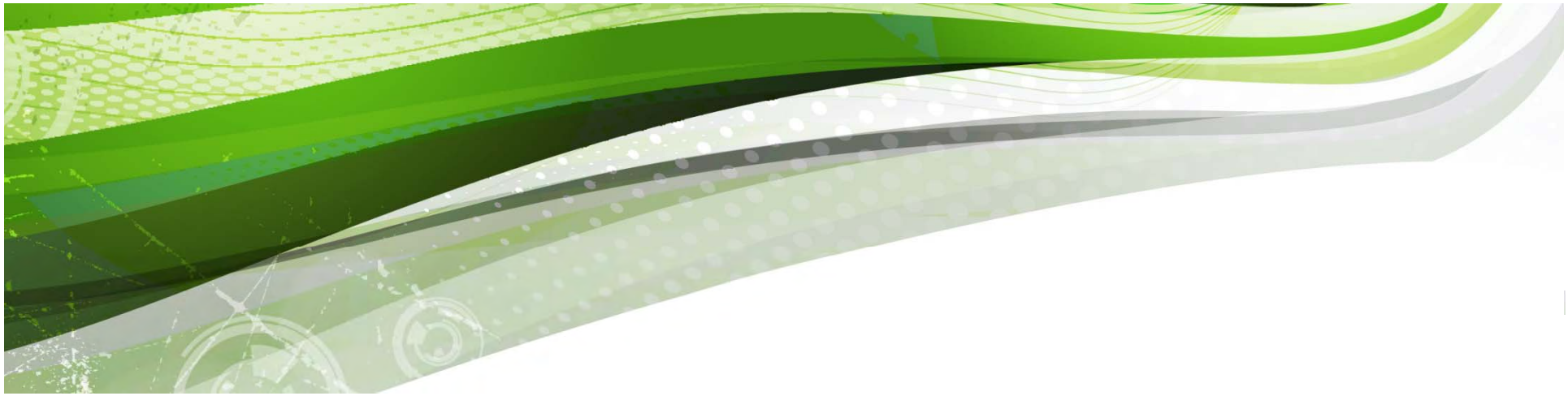
A Modern Standard for a Modern Grid



Agenda

13:00	Registration
13:15	Welcome and introduction to OSGP
13:30	The Open Smart Grid Protocol (OSGP) and its environment; Smart Metering and beyond; the future is about Smart Grids; Vision behind OSGP
13:45	OSGP support and development; The Energy Service Network Association (ESNA); Sharing the knowledge and experience; what it will bring you
14:00	OSGP main concepts, part I; The operational and functional overview of OSGP
15:00	Coffee / Tea break
15:30	OSGP main concepts, part II; Interoperability with other Standards and Protocols; OSGP/COSEM functionality, MEP, M-bus
16:00	OSGP Information Security and Data Protection
16:30	OSGP conformance testing and inter-operability testing
17:00	Questions and Answers
17:30	End of Program

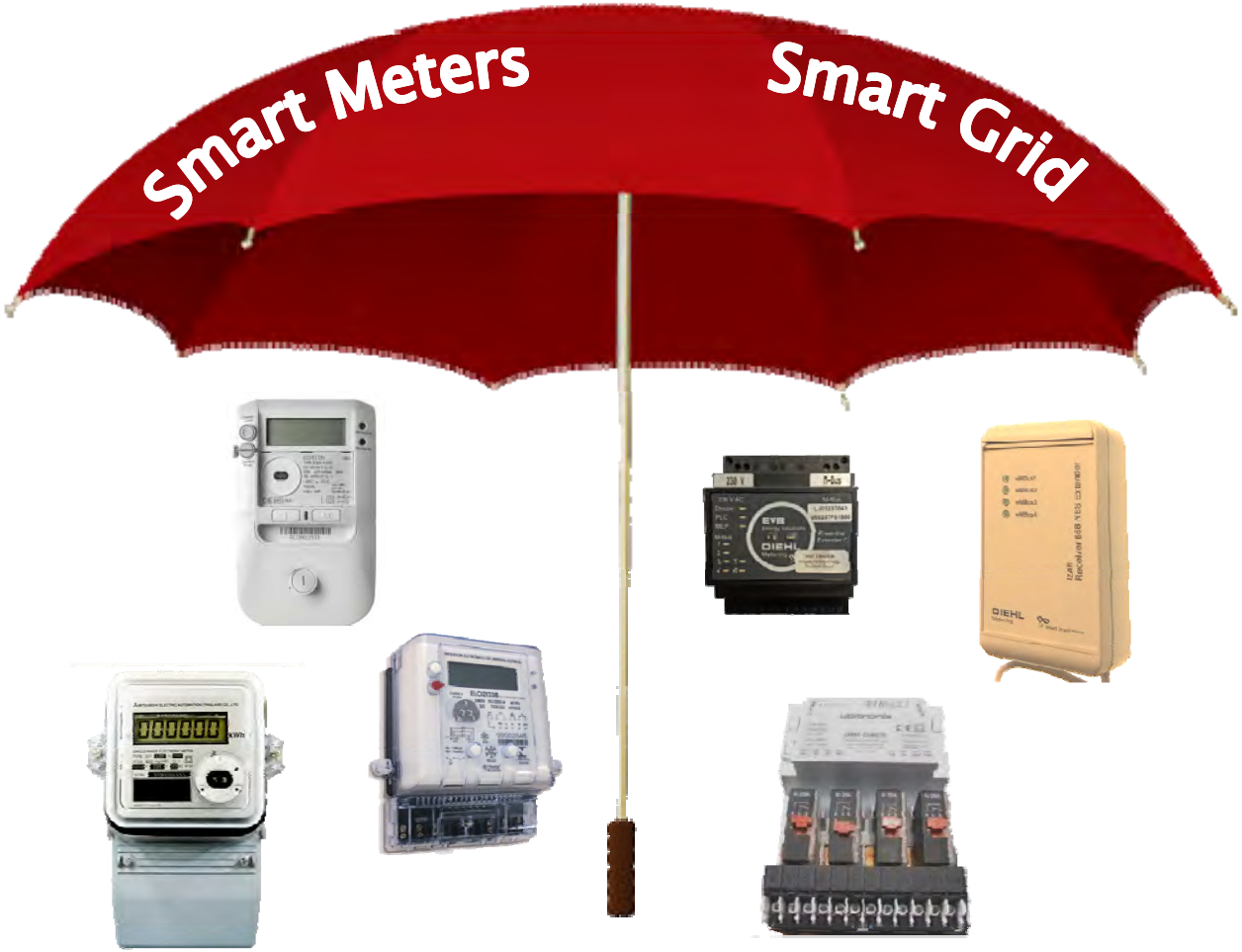
Vision Behind OSGP



OSGP – A Modern Standard For A Modern Grid

OSGP Covers Smart Meters and Other Smart Grid Devices

- OSGP lays a framework for the future
- Smart grid, not just smart meters
- Leverage common infrastructure over multiple applications



OSGP
Open Smart Grid Protocol

OSGP Is Built For a Networked Grid

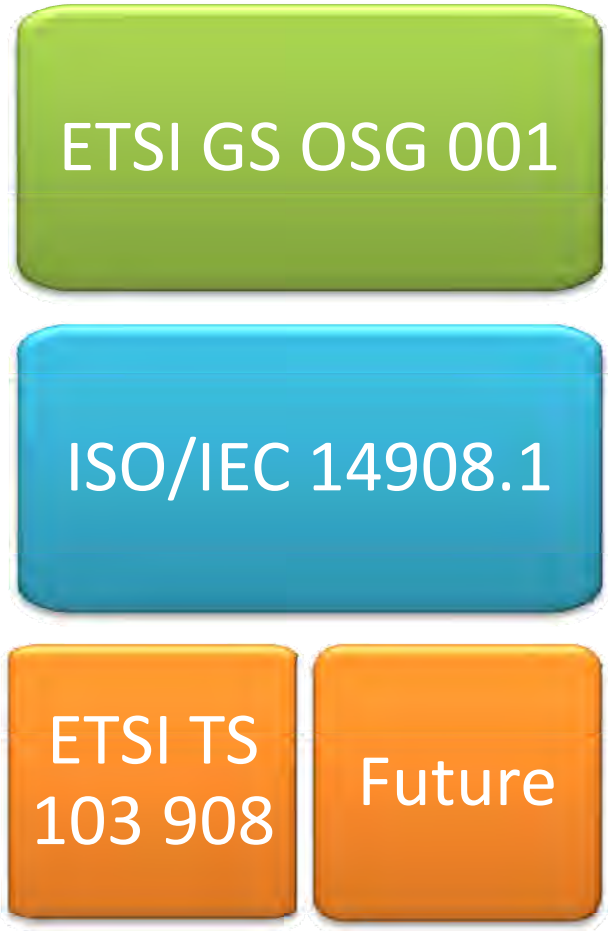
- Brings high-performance and reliability TODAY
  - Best-in-class CENELEC A-band power line performance
  - Highly efficient and scalable communications and control protocol
  - Adaptive and directed meshing
- Provides headroom to grow and support future applications
- Built-in, mandatory security and privacy for every data exchange
- Interoperability with other standards
  - Enables technology evolution while preserving past investments

OSGP Standardized by European Telecomms Standards Institute (ETSI)

- Produces globally-applicable standards for Information and Communications Technologies (ICT)
- EU-recognized standards organization along with CEN a CENELEC
- History of technical excellence, quality and openness
- Specifications available on the web, free of charge

OSGP—A Set of Open Standards

- Layered OSI protocol stack
- ETSI Group spec GS OSG 001
  - Application layer protocol
  - Media independent
- ISO/IEC 14908.1 Control Networking
  - Layers 2 to 6
- ETSI Technical spec TS 103 908
  - High performance power line communication media
  - Supports many smart grid device types
- Designed for additional media
- Supported and maintained by ESNA

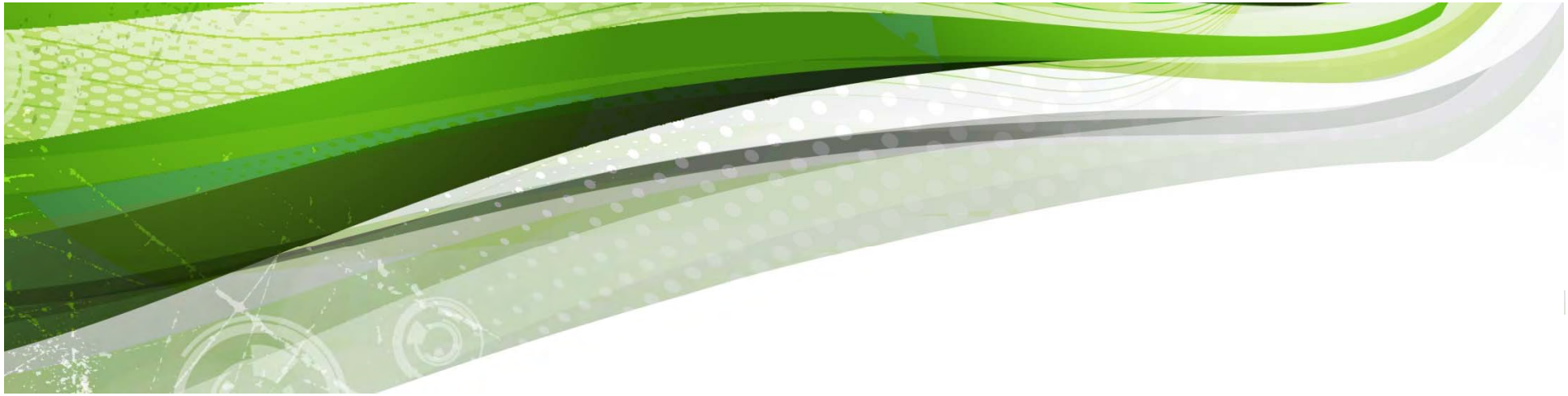


OSGP-DLMS/COSEM Interoperability

- Enables utilities to use a common data model (DLMS/COSEM) at the enterprise for smart meters
- While gaining the proven reliability, scalability and performance of OSGP
- And the ability to integrate other non-metering smart grid devices via OSGP

OSGP
Open Smart Grid Protocol

The Energy Service Network Association (ESNA)



Introduction to the Energy Services Network Association (ESNA)

- Global, non-profit industry trade association
  - Membership open to any company or individual
- Membership represents entire smart grid value chain
  - Utilities, solution providers, enterprise software vendors, device and meter manufacturers
- Working together to realize the next generation of the smart grid
- Accepted by the European Commission as Stakeholder

ESNA Mission

- Promote and advance the capabilities of innovative solutions for utilities based on the Open Smart Grid Protocol (OSGP)
- Pursue standardization of OSGP at appropriate international standards organizations
- Ensure, to the maximum feasible extent, that OSGP remains interoperable with any standard or protocol established or adopted by the European standardization organizations for purposes of smart meter communication in the European Union

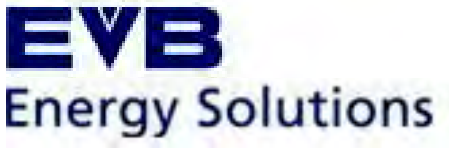
ESNA Board Represents End-Users and Industry

Chairman

Vice-Chairman

Treasurer

Other Board Members



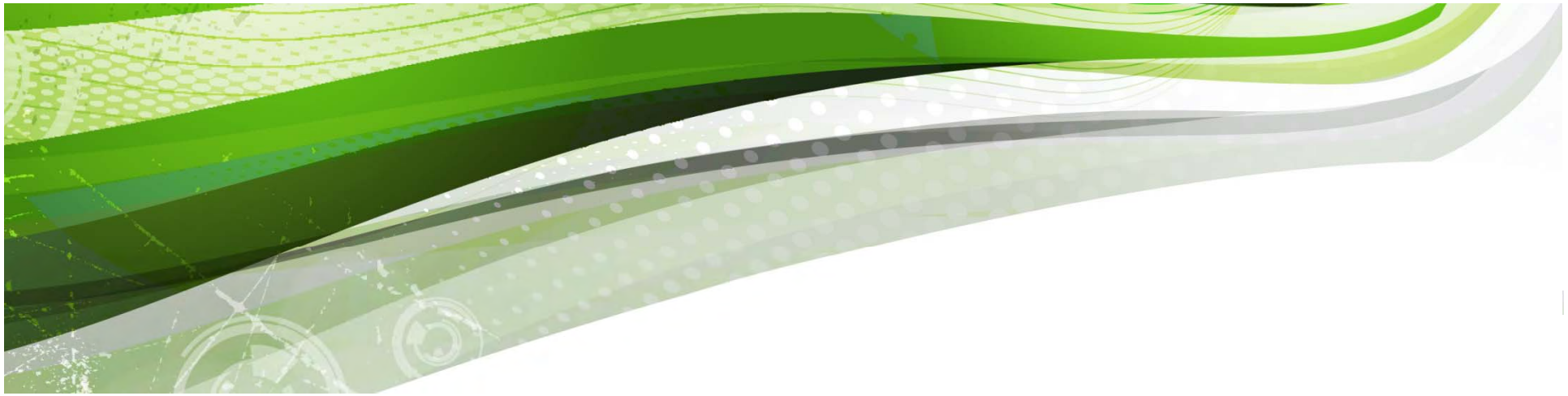
ESNA is Committed to Interoperability

- ENSA and DNV KEMA working together to define OSGP conformance test process
- Vendor-independent certification process (ESNA) and conformance testing (DNV KEMA) provides third-party validation of OSGP implementations
- Benefits both utilities and device manufacturers

ESNA/OSGP Booth at Metering Europe 2012

OSGP Open Smart Grid Protocol

OSGP Main Concepts, Part I



OSGP—A Set of Open Standards

- Layered OSI protocol stack
- ETSI Group spec GS OSG 001
  - Application layer Protocol
  - Media independent
- ISO/EN14908.1 Control Networking
  - Layers 2 to 6
- ETSI Technical spec TS 103 908
  - High performance power line communication media
  - Support many smart grid device types
- Designed for additional media
- Supported and maintained by ESNA

ETSI GS OSG 001

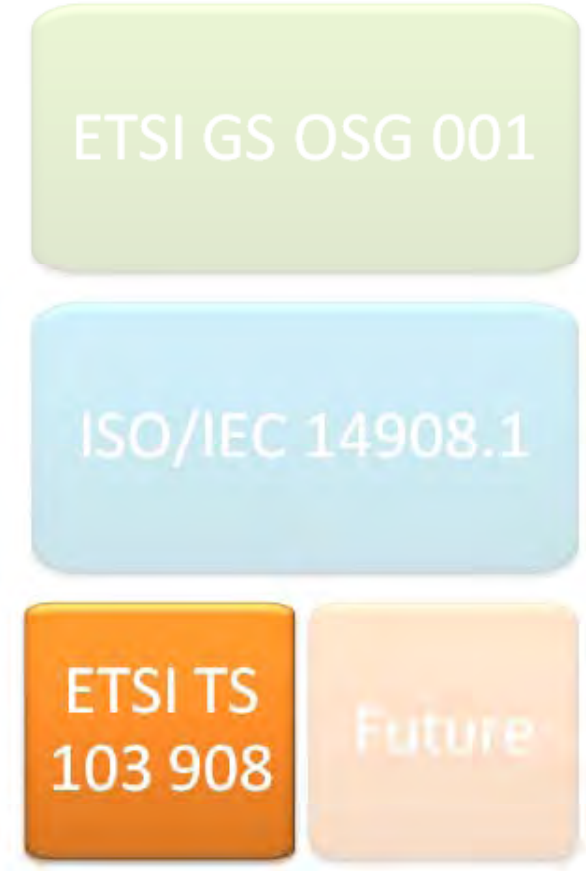
- Models devices as a collection of data, methods and events
- Very bandwidth efficient, enabling high performance on bandwidth constrained media
- Includes core meshing services for reliable, scalable operation
- Built-in, mandatory security and privacy for every data exchange
- Deployed in over 3.5 million smart grid devices

ISO/IEC 14908.1

- Optimized, multi-application control network protocol stack
  - Provides reliable delivery, multi-cast messaging
  - Low overhead enables high performance without requiring high bandwidth
- Field proven in over 100 million devices
- Media independent

ETSI TS 103 908

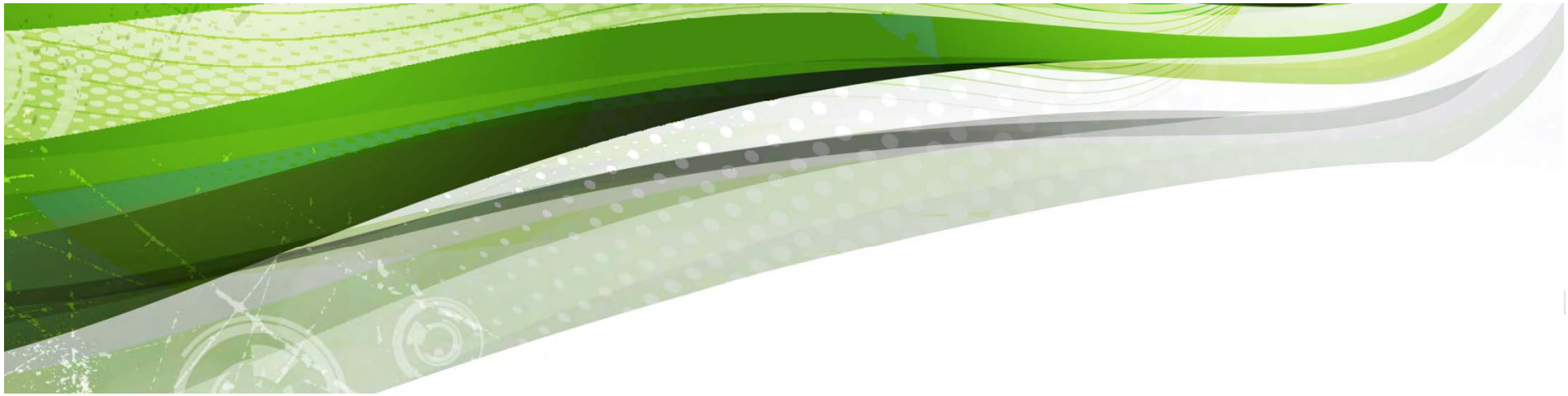
- Based on ISO/IEC 14908.3 2006 with adaptations for A-band operation, per EN 50065-1
- High-performance narrow band power line channel for control networking in the smart grid
- Binary Phase Shift Keyed (BPSK) modulated carrier
- 3.24 kbps raw channel data rate
- Deployed in over 35 million smart meters and grid devices



Open To The Future

- Any media can be used with OSGP
  - C-Band power line
  - Emerging high speed power line technologies (IEEE 1901.2, G3, PRIME)
  - RF technologies (WiFi, 802.15.4, Wi-SUN)
  - Ethernet
  - Fiber optics
  - •••

ETSI TS 103 908



Key Attributes of ETSI TS 103 908

- Very low overhead leads to high effective data rate
  - 3.24 kbps raw channel rate
  - 2.36 kbps effective data rate
- BPSK modulated carrier enables high link budget
  - The higher the link budget, the few times repeating will be needed
  - The higher the link budget, the more choices will be available for repeating paths when needed

Definitions of Terms

- Raw Data Rate
  - Maximum rate that raw bits can stream onto the media – e.g., 1Gbps Ethernet

- Frame Rate
  - A grouping of bits to transport a packet on the media e.g., 1 Gbps Ethernet - Frame rate of 1,488,096 to 81,274 f/s (frames/seconds)

Looking Inside a Frame

- Overhead (OH)
  - Inter frame (packet) gap, MAC preamble, MAC addressing,
- Error correction
- Payload:
  - The data potion of the packet
  - May include its own application protocol level addressing, overhead and data

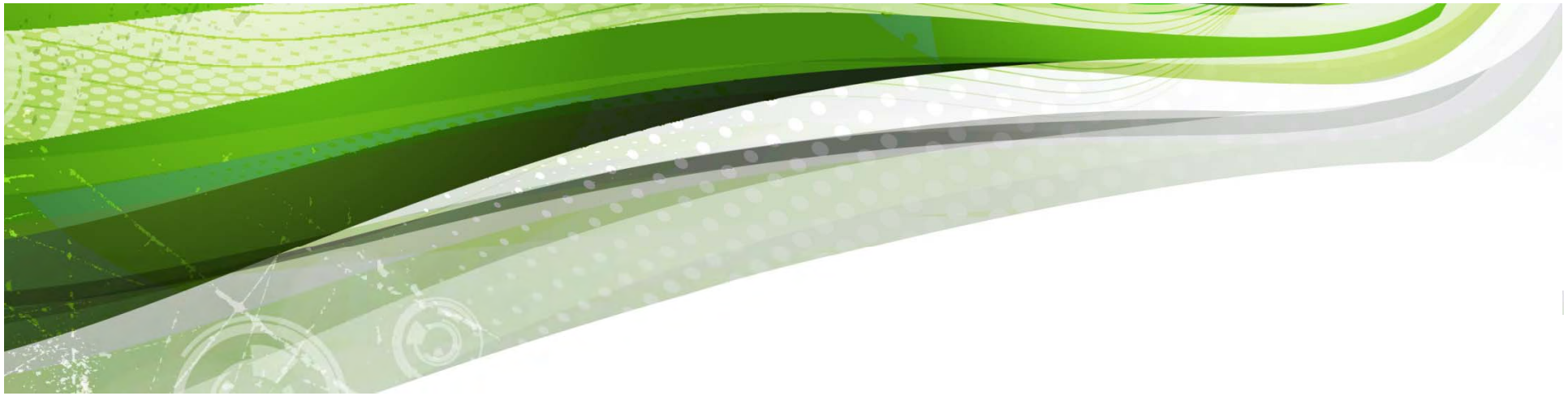
Effective Data Rate (DReff)

- The data you actually care about
  - bits/sec of payload transferred in a complete frame after accounting for all overhead
- Effective data rate is always lower than raw data rate
- How much lower varies based on a number of factors
  - Overhead varies by encoding scheme
  - Multiple data rate support increases overhead % at higher speed (inter-packet gap size based on slowest speed)
  - Encoding schemes affect the link budget and therefore affect the need for and the efficiency of repeating
  - Time spent maintaining the mesh subtracts from bandwidth available for useful work
- Raw date rate is the most commonly talked about metric, but effective data rate is the most important determinant of system performance and scalability

ETSI 103 908 Is Very Efficient

- Many power line encoding schemes have 80% or more overhead
- ETSI 103 908 has less than 30% overhead
  - Over 3x the amount of payload per delivered frame
- Building on ETSI 103 908 gives OSGP a performance boost
  - Further augments by application layer efficiency

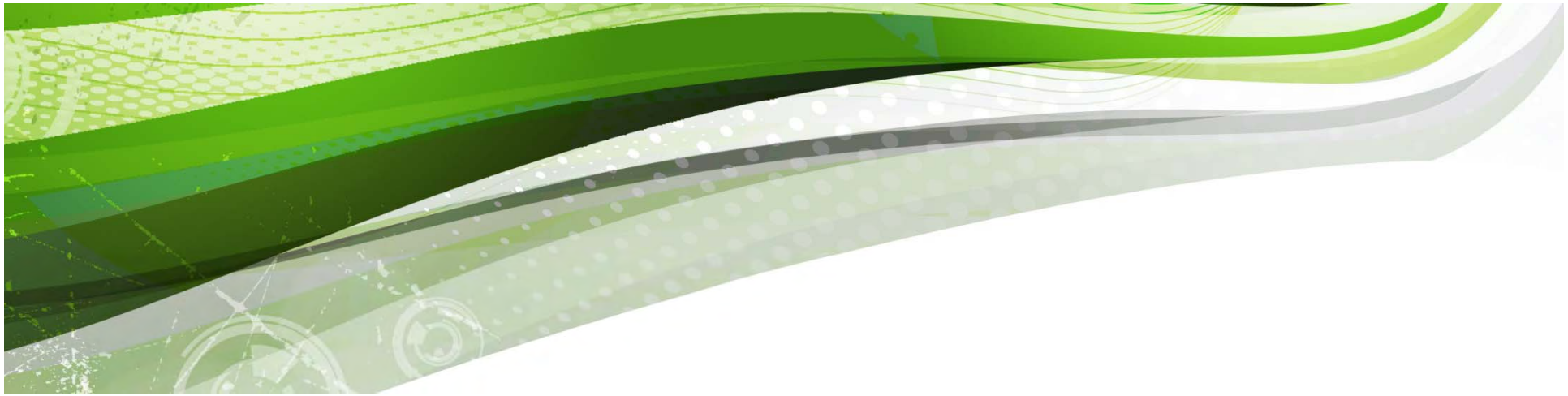
ETSI GS OSG 001



Agenda

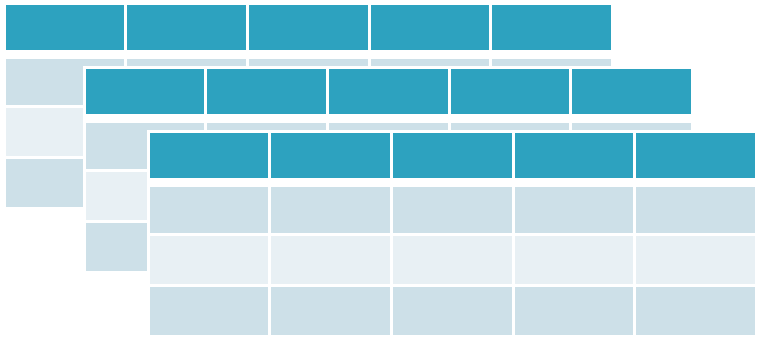
- OSGP device model
- Network formation and maintenance services
- Core protocol services

OSGP Device Model



OSGP Device Representation

- OSGP uses a representation-oriented model for smart grid devices
  - Data (attributes)
  - Procedures (methods)
  - Events
- Concept of “basic” (found in IEEE 1377) and “extended” functionality



OSGP is a REST Style Protocol

- From wikipedia
  - **RE**presentational **S**tate **T**ransfer (REST) is a style of software architecture for distributed systems such as the World Wide Web. REST has emerged as a predominant Web service design model.
- Key goals of REST include:
  - Scalability of component interactions
  - Generality of interfaces
  - Independent deployment of components
  - Intermediary components to reduce latency, enforce security and encapsulate legacy systems

REST vs Object Oriented Model

- REST
  - A few methods (read, write...) to interact with a document-like representation of the information (attributes...)
- Object oriented
  - Many methods to interact with an opaque encapsulation of the data in the object model

- OSGP uses a REST model
- DLMS/COSEM uses an object-oriented model
- You can easily map data and methods between the two models

OSGP Data Tables

- Tables provide an efficient, structured way of describing device information
  - Data addressed by table, row, column
  - Devices may store data internally however they wish
- 109 tables (41 basic, 68 extended)
- All information exchange done via tables
  - Device status, history, events, data logs, billing data, etc.
- Tables can be read only or read/write
- For bandwidth efficiency and performance, multiple data elements or even entire tables can be read with a single request

Pending Tables

- Pending tables provide a way to synchronize configuration changes in multiple OSGP devices to a single moment in time
- For example, to enact a new time-of-use calendar in all the meters in a particular region at precisely the same time

Example OSGP Tables

- Device Identification
- Utility Information
- Group Configuration
- Calendar
- Clock
- Time Offset
- Critical Events
- Daily Consumption
- Self Read Data
- Historical Demand Reset Log
- History Log Data
- Load Profile Data
- Maximum power or current level control
- Power Quality
- Time-Based Relay Control
- M-Bus Data Type Table
- M-Bus/MEP Device Config
- M-Bus/MEP Device Status
- MEP Device Configuration
- MEP Device Configuration
- MEP Inbound Data Space
- MEP Procedure Response
- MEP Recurring Read Log
- MEP Transaction Request Table
- MEP Transaction Response Table

OSGP Procedures

- Procedures are remote method calls
  - Modify device behavior
  - Change configuration
  - Invoke an action
- 54 procedures (8 basic, 46 extended)
- Procedures are managed through request/ response tables

Example OSGP Procedures

- Record Self-Read
- Post One Time Read Request
- Set Date and Time
- Set Tariff
- Switch maximum power or current level
- Add prepay credit
- Add/Remove Group ID
- Change System Clock by Delta
- Activate Feature
- Change OMA Encryption Key
- Clear Alarms
- Demand Reset
- Enable/Disable Battery
- Activate All Pending Tables
- Activate Specific Pending Tables
- Clear All Pending Tables
- Clear Specific Pending Tables
- Download Code Packet
- MEP Download Initialize
- Post MEP Data
- Clear MEP Alarms
- Remove M-Bus/MEP Device
- Post On-demand M-Bus Request
- Read/Write Diagnostic Counters
- Remote Disconnect Reconnect

OSGP Events

- Events allow devices to report information asynchronously
  - Alerts/alarms (e.g., tamper)
  - Conditions/thresholds being met (e.g., under voltage)
  - Exceptions detected (e.g., phase loss)
  - Self-check errors (e.g., low battery detected)
  - State or status change (e.g., season change)
- 96 events (50 basic, 46 extended)
- Events are reported through tables
- Events are cleared with procedures
- OSGP provides a standard way for devices to send extended events

Example OSGP Events

- Primary Power Down
- Procedure Invoked
- Table Written To
- History Log Cleared
- Event Log Cleared
- Demand Reset Occurred
- Self-Read Occurred
- Daylight Savings Time On
- Season Change
- Tier Switch Change
- Self Check error Detected
- Low Battery Detected
- Tamper Detected
- Magnetic Tamper
- THD Event Detected
- Prepay Credit Exhausted
- Max Power Level Changed
- Maximum Value for Voltage THD Event
- M-Bus Device Alarm
- M-Bus Alarm Match

Advanced Use Case Example

Reading Load Profile Data

- Load profiling is the storage of data snap shot taken at regular intervals
- All OSGP devices support a load profile data log that can be configured to record up to 16 different values at once
- The load profile log is divided into groups of data called blocks,
  - There are a configurable number of intervals per block
  - There is a configurable length of each interval
- Load profile settings remotely configurable using EP11 (Configure/Reset Load Profile Data Set)

Advanced Use Case Example

Reading Load Profile Data

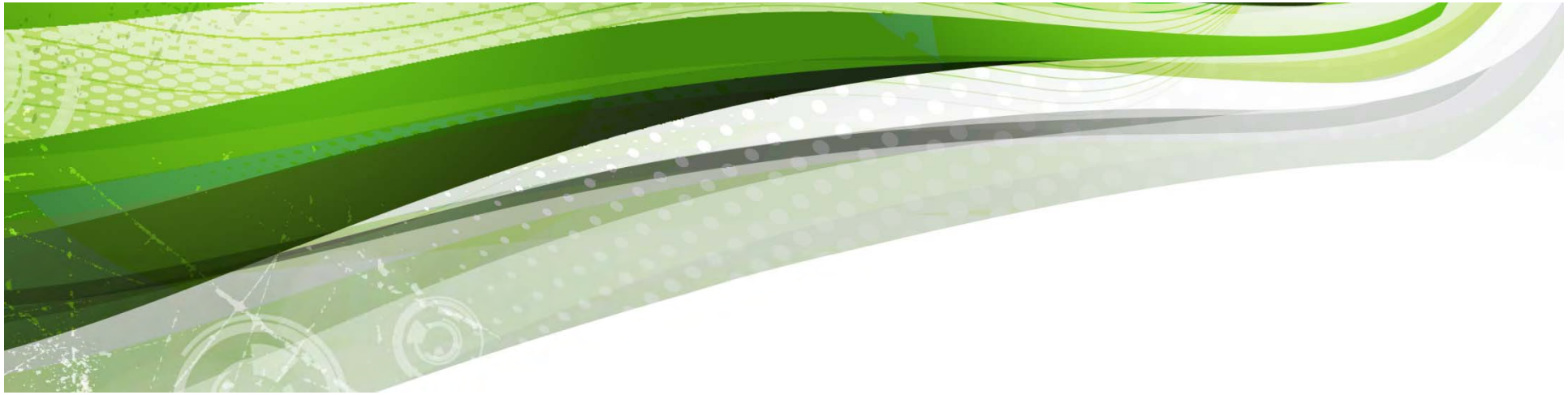
- Four tables applicable to load profiles
- BT61 (Actual Load Profile)
  - Gives information about the configuration of the load profile (total size, number of blocks, intervals per block, channels per interval)
- BT62 (Load Profile Control)
  - Specifies data sources for each channel
- BT63 (Load Profile Status)
  - Gives status information on number of blocks present in the log
- BT64 (Load Profile Data)
  - Time-stamped load profile records

Advanced Use Case Example

Reading Load Profile Data

- To read the most recently recorded load profile data in the OSGP device:
  - If you don’t already know how the log is configured read BT61 and BT62 to determine what channels are being logged and the log setup (total size, block size, interval)
  - Read the "Number of Valid Blocks" and "Last Block" fields in BT63 to determine where the next set of unread data sits in BT64
  - Perform a partial read(s) of BT64 to fetch the new load profile data

Network Formation and Maintenance Services



Key Goals of OSGP Discovery and Maintenance Services

- Lower cost and complexity of system deployment
  - Enable device discovery
  - Enable topology discovery
  - Enable automatic repeater path configuration
- Enable systems to dynamically adapt to change in the field
  - Detect when devices have moved from one transformer to another
  - Adapt repeating paths to changing conditions
- Provide services that can eliminate or minimize need for manual intervention

Automation Enabled Through Three Core Services

- Fast Commission Message (FCM)
- Automated Device Discovery (ADD)
- Automatic Topology Management (ATM)
- Sent as ISO/IEC 14908.1 messages with specific message codes

Fast Commission Message (FCM)

- ISO/IEC 14908.1 commissioning is the process of loading a device with its network personality
  - Network domain/subnet/node address, domain authentication key, etc.
- FCM enables all required information to be sent in a single message rather than multiple messages
  - Greatly increases bandwidth efficiency and reduces commissioning time

Automated Device Discovery (ADD)

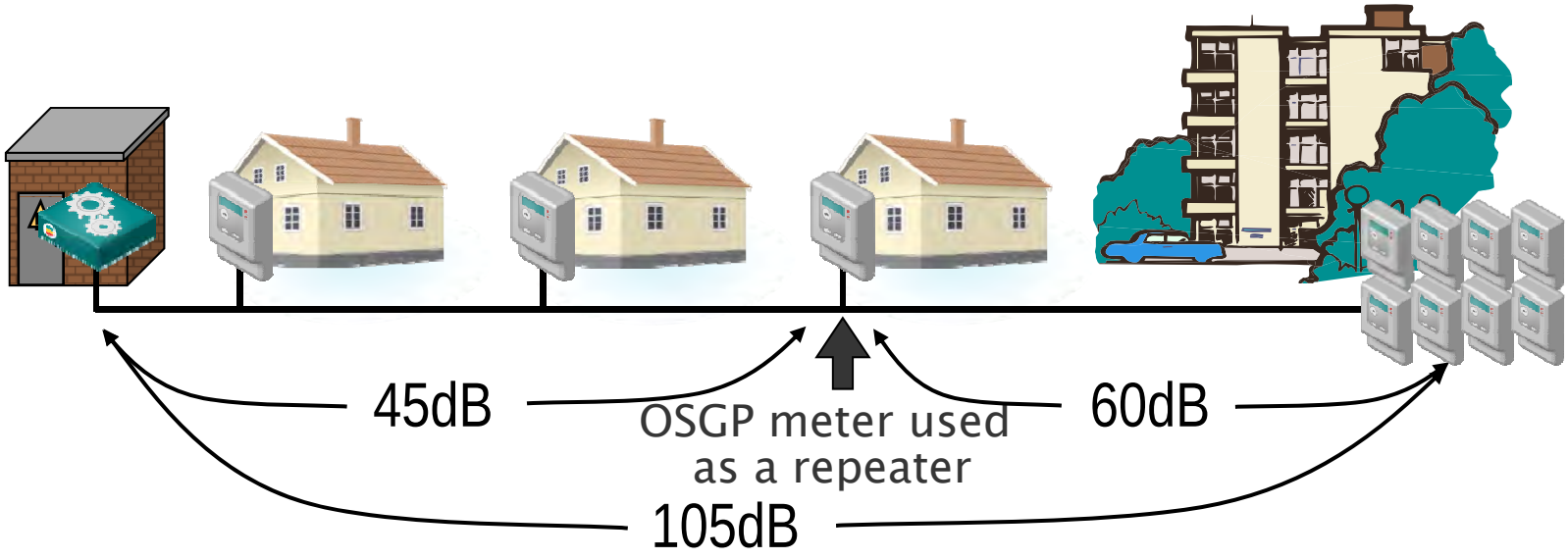
- Builds on ISO/IEC 14908.1 discovery with a common OSGP “global discovery domain”
  - All OSGP devices belong to the global discovery domain
  - Also belong to an application domain as part of FCM process
- ADD supports discovery of devices and DCs
- Discovery can be made through repeaters
  - Even if the repeaters are uncommissioned
  - Even if the repeaters are managed as part of another ISO/IEC 14908.1 domain
  - Devices can be discovered if they are in the global discovery domain

Automatic Topology Management (ATM)

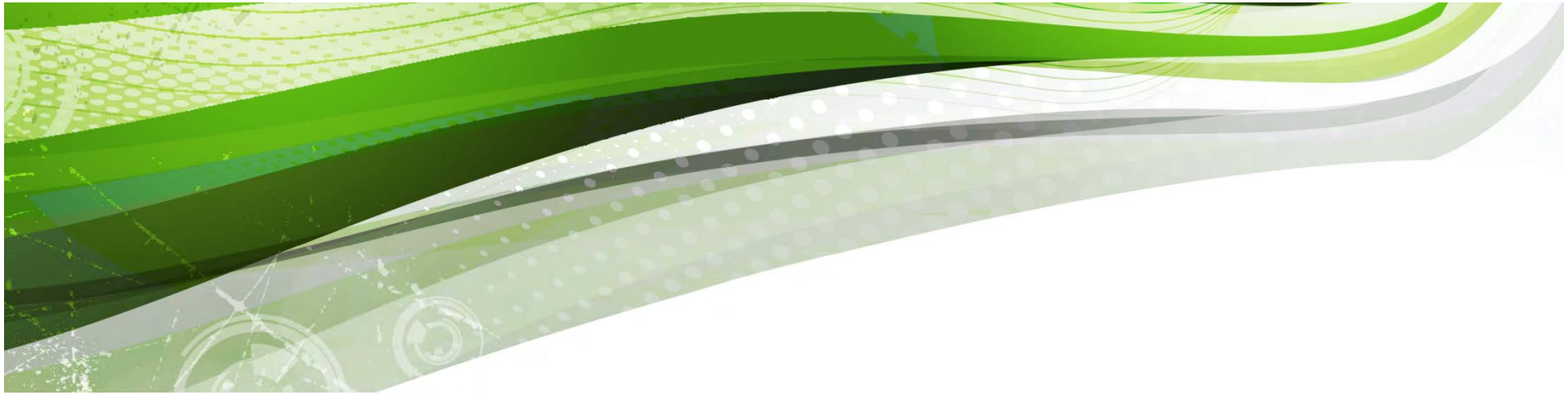
- Built on ISO/IEC 14908.1 query mechanism
- Adds capability for devices to report additional information that can be used by a concentrator when selecting repeat paths (meshing)
  - Signal strength
  - Communications margin
  - Hop counts to reach device
- Reported automatically as part of ADD
- Can be requested at any time to monitor network quality

OSGP Meshing

- Any OSGP device can be a repeater
- OSGP supports repeating with up to 16 hops
- Algorithm used to select repeaters open to innovation by DC developers



Core Protocol Services



Introduction

- OSGP resides at layer 7 (application layer) of ISO/IEC 14908.1
- General structure of 14908.1 application layer APDU is:

Destin and Type (1 or 2 bytes)	Data (variable)

- Different message codes are used for different network services such as data reads, network formation and network maintenance
- OSGP supports full remote device configuration
- OSGP does not support segmentation. Partial reads and writes are used to read/write larger tables

Introduction

- All messages are request/response (like HTTP)
  - Request specifies command code and parameters
  - Response returns return code plus results, if any
- Response codes
  - 0x00 Command accepted
  - 0x01 Error
  - 0x02 Service Not Supported
  - 0x03 Insufficient Security Clearance
  - 0x04 Operation Not Possible
  - 0x05 Inappropriate Action Requested
  - 0x06 Device Busy
  - 0x0A Invalid Service Sequence State
  - 0x0B Digest Error
  - 0x0C Sequence Number Error
  - 0x1E Incompatible Error
  - 0x1F Interface Change

Full Table Read Service

- Used to read the entire specified data table in the device
- Request parameters
  - Command code (0x30)
  - Table ID
- Response contents
  - Response code
  - Number of data bytes returned
  - Data

Partial Table Read Service

- Used to read a portion of a device table
- Request parameters
  - Command code (0x3F)
  - Table ID
  - Starting offset in the table
  - Number of data bytes to be read (84 maximum)
- Response contents
  - Response code
  - Number of data bytes returned
  - Data

Full Table Write Service

- Used to write the entire specified data table in the device
- Request parameters
  - Command code (0x40)
  - Table ID
  - Number of data bytes to be written
  - Data
- Response contents
  - Response code

Partial Table Write Service

- Used to write a portion of a device table
- Request parameters
  - Command code (0x4F)
  - Table ID
  - Starting offset in the table
  - Number of data bytes to be written (75 maximum)
  - Data
- Response contents
  - Response code

Procedure Invocation

- Procedures are managed through tables
  - Initiated by writing into BT07; response read from BT08
- Request specifies
  - Procedure number to execute
  - Sequence number used to correlate response
  - Procedure parameters (if any)
- Response includes
  - Procedure number last executed by device
  - Sequence number
  - Result code

Transactions

- Transactions provide a way to safely execute complex interactions with an OSGP device
  - E.g., write a large table through multiple partial table writes
  - Up to 769 bytes per transaction
- Transactions ensure that either all the requests occur or none do
- Transactions are managed through tables
  - Transaction request (ET27) and transaction response (ET28)
  - MEP transaction request (ET52) and MEP transaction response (ET53)

Secure Broadcasts

- OSGP provides a secure broadcast mechanism to deliver a single message to multiple devices
  - Quick delivery of time-critical commands (e.g., load shed request)
  - Efficient delivery of shared information (e.g., new firmware images)
- Devices can be belong to up to 10 groups
  - EP27 used to add/remove group IDs
- Broadcasts are identified by a sequence number to protect against replay attacks
  - Range of sequence numbers configured into device at installation via ET04
- Devices process broadcast messages with valid sequence numbers addressed to a group to which they belong

Secure Firmware Download

- OSGP supports interoperable unicast and multicast secure firmware download
  - Built on secure broadcast mechanism
  - All OSGP devices support code download
- Initialize download with EP08: Erase code memory
  - Instructs devices to prepare for download
- Download code in segments using EP09: Download Code Packet
  - Writes new image, segment by segment, into download area. Verification is performed by reading ET17
- Invoke EP10: Switch Code Bank
  - Instructs device to switch over to new image
  - Each device indicates Code Bank Changed event

Summary

- OSGP is designed from the ground for efficient, reliable, scalable smart meter and smart device networks
- ETSI 103 908 power line gives OSGP a performance boost through high link budget and low overhead
- ETSI GS OSG 001 implements a modern REST model for efficiency and provides key capabilities for automatic and reliable network formation and maintenance

Coffee Break