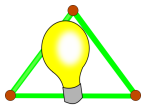
Open DC Grid Project

2020 July



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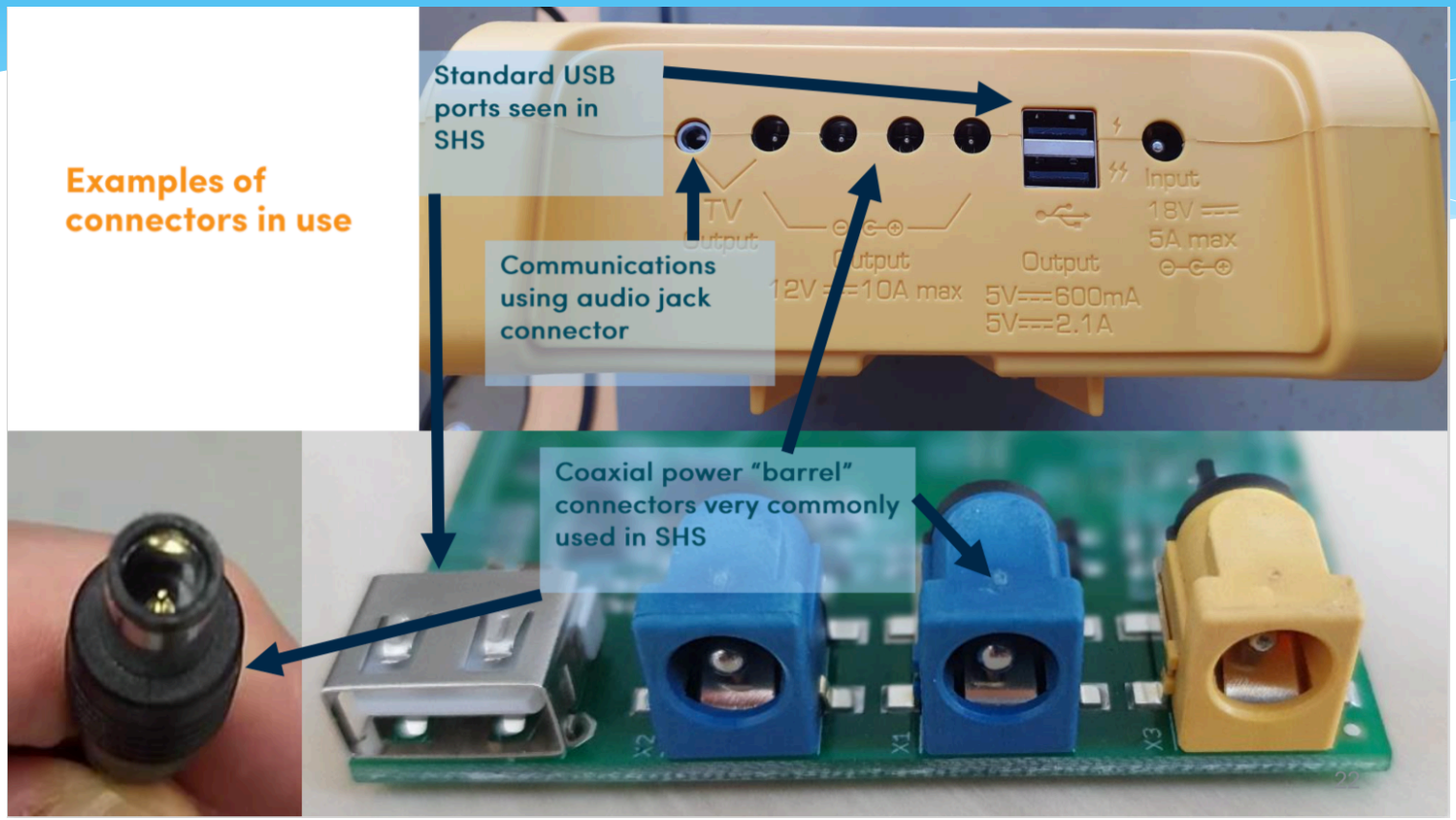
Agenda

- GOGLA Interop Presentation – Garick Lee
- ODG 12V Link Proposal
- Communications
- Related Standards / Industry Developments
- Next Meeting / Feedback

12V Link - Objective



* Enable marketplace – focus on OEMs, retail someday
  * 12V Appliances – enable low-cost PAYGO – lighting as a service
  * Power sources – SHSs, DC Grids, AC power adapters, combined

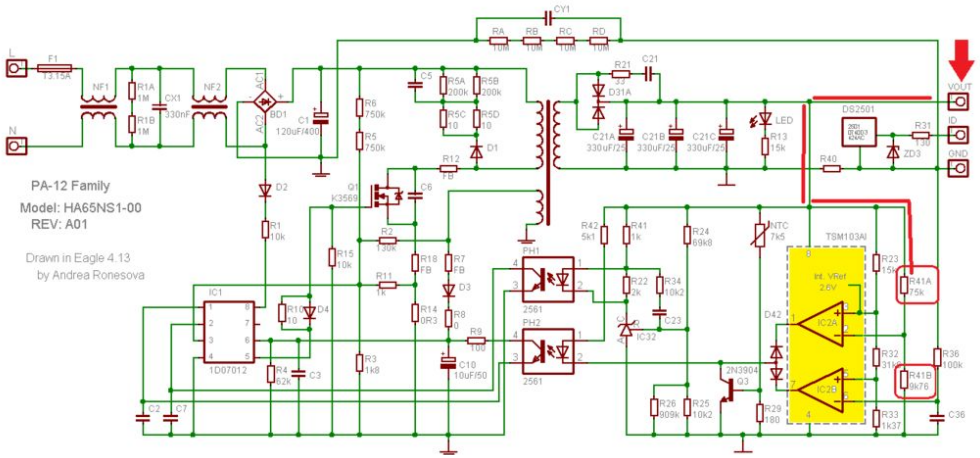
ODG 12V Link Proposal

* Low cost connections with expandability
* Compatible with most 12V devices and sources
* Lower cost but more power than USB
* Minimizes barrel connector compatibility issues
* Optional communications for remote management
* Multiple sources permitted
* Goof resistant with informal wiring
* Compatible with existing AC power adapters
* Consistent with ISO 16750 (12V auto electrical)

3-terminal barrel connector
CUI PJ-096H or equivalent ~$.35

3-terminal plug
Philmore 274 or equivalent

12V Link – Barrel Connector Compatibility



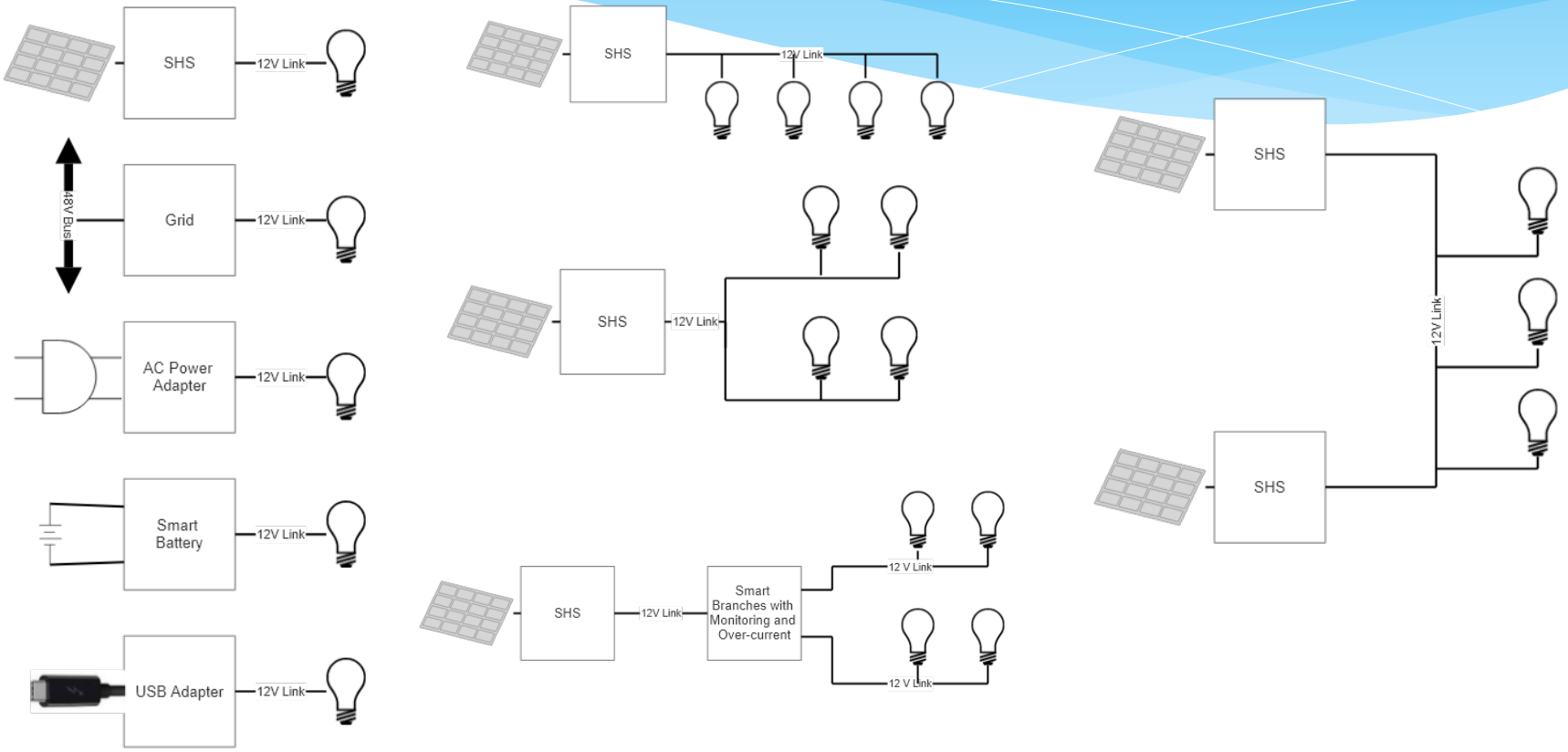
HP Laptop Power Supply

* Compatibility issue: laptop power adapters
* Solution:
  * Loads: 10V to 20V – permits use of power adapters
  * Sources: 10.5 to 15V – compatible with existing 12V devices

12V Link – Wiring Flexibility

* 4 port types
  * Load – female socket recommended, male plug optional
  * Source – female socket only
  * Bidirectional – female socket only
  * AC power adapter – male plug and cord
* Passive (no electronics) extension cords, port expanders
  * Similar to AC
* Supports bidirectional ports (battery)
* Supports multiple sources per bus (grid)

12V Link - Topologies



12V Link – Power Saving Modes

* Objective – save battery from overdraw
* Sleep Mode 9V – 10V
  * Primary functions off
  * Communications (if supported) still active
  * Max current 10 mA / node
* Disconnect Mode < 9V
  * All functions off
  * Max current 100 uA / node

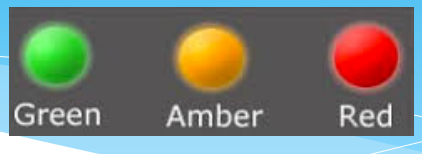
12V Link – Tests and Parameters

Most based on ISO 16750 / ISO 7637-2

* Overvoltage protection
* Overcurrent protection
* Reverse polarity
* Dropout (100 msec)
* Noise immunity
* Slow voltage rise/fall
* Transient immunity – TBD
* Open circuit
* Droop control
* Constant power load stability

Symbol	Value	Description
V_{max_s}	15 V	maximum source voltage
V_{max_l}	20 V	maximum voltage for loads operating normally
V_{max_a}	20 V	maximum AC adapter voltage
V_{ovp}	25 V	minimum overvoltage protection
V_{ovs}	25 V	source disconnect overshoot
V_{cond}	25 V	load disconnect overshoot
V_{min_s}	10.5 V	minimum source voltage
V_{min_l}	10 V	minimum voltage for loads operating normally
V_{min_c}	9 V	minimum voltage for communications circuits
$V_{reverse}$	-25 V	minimum reverse protected voltage
V_{AC}	1 V P-P	minimum AC noise protection
$V_{dropout}$	4.5 V	maximum voltage during drop-out protection test
I_{max}	8 A	maximum current through a connector

12V Link – Labeling and Indicator



Load Indicator

Source/BiDi Indicator

* Label
  * ODG Symbol
  * Port type symbol
  * Power output or load
* Indicator light (multicolor LED)
  * Used on all ports
  * Explains conditions
  * Patterns for color-blind?
  * Power saving timeout
    * Invert pattern at 1 minute?

Color	Blink Dots	Description
Green	1	load receiving normal power
Green	2	load receiving normal power but without communications
Amber	1	load or source voltage below V_{min_l} (sleep)
Amber	2	load with insufficient priority for power
Amber	3	load or source PAYG disabled
Red	1	source over-current
Red	2	reverse polarity
Red	3	overvoltage or device malfunction
blue	1	source suppling normal power
blue	2	source suppling normal power but without communications

12V Link – Current Surges

* Cold start
  * Recommend [require?] random delay on start
  * Staged startup for communicating loads
  * TBD for capacitor charging
* Surges - TBD
  * Permit brief surges?
  * Require soft start?

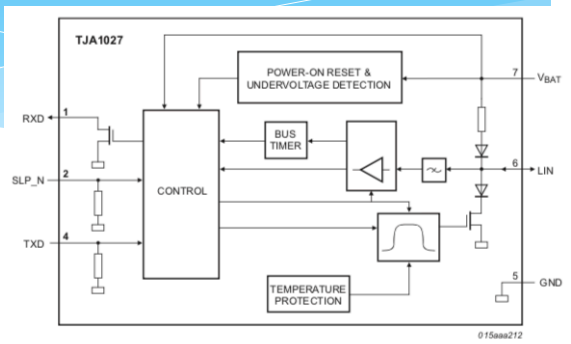
12V Link – Comm Goals / Non-Goals

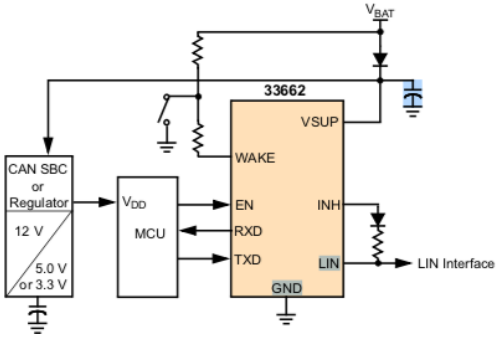
* Goals
  * Very low cost (<< $1 / port)
  * Simple wiring w/o special cables
  * Automatic configuration – plug and play
  * Very low power when not in use
  * Simple protocols for *very* memory constrained MCUs
  * Operation within homes and modest structures
* Non-Goals
  * High data rates: 1 kbps OK
  * Direct internet access: proxy / bridges OK
  * Encryption / security: optional, not required
  * Long distances transmissions: 40 m OK

12V Link – Comm Implemetation

ODGTalk

* Physical layer based on LIN bus
  * 40 m over regular wires (twisted pair not required)
  * 12V swing for good noise immunity
  * 1 – 20 kbps data rate
  * Very low cost transceivers ($.35) – many sources
  * Typically immune to +/- 45V spikes
  * Transceiver sleep mode
* Link layer different
  * Auto address assignment – LIN static or extra wires
  * Auto data rate selection – LIN static
  * Peer to peer messages – LIN master / slave
  * Uses UART "multiprocessor mode" to minimize power
  * Any node can be bus manager (pull-up, address registration)





12V Link – Comm Details

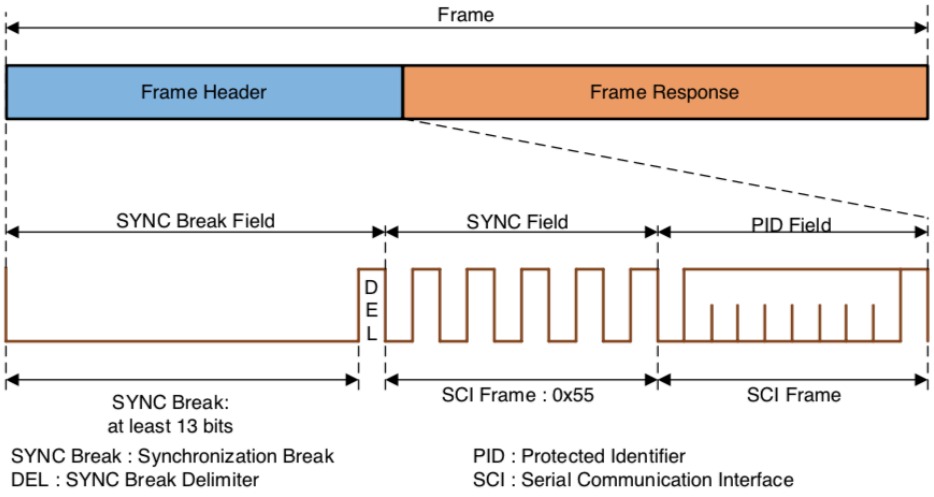


Figure 5. LIN® Frame Header Explanation

Figures from: TI SLLA383

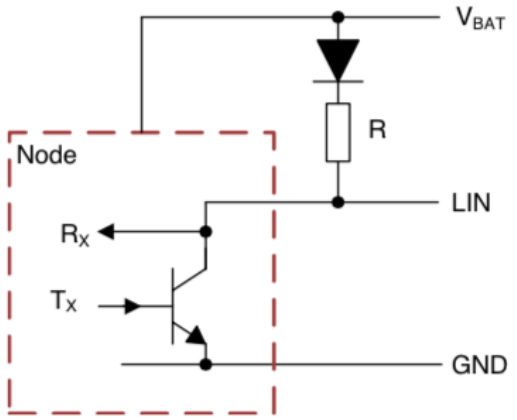


Figure 7. Simplified LIN® Driver Schematic

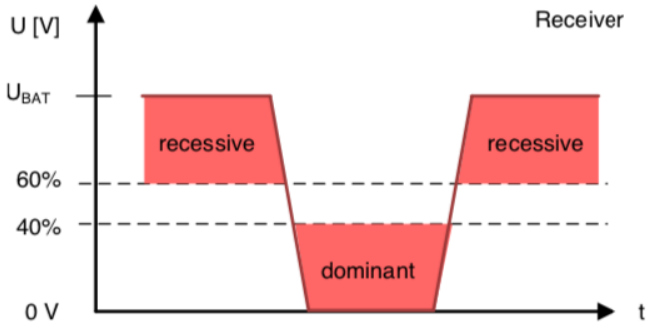
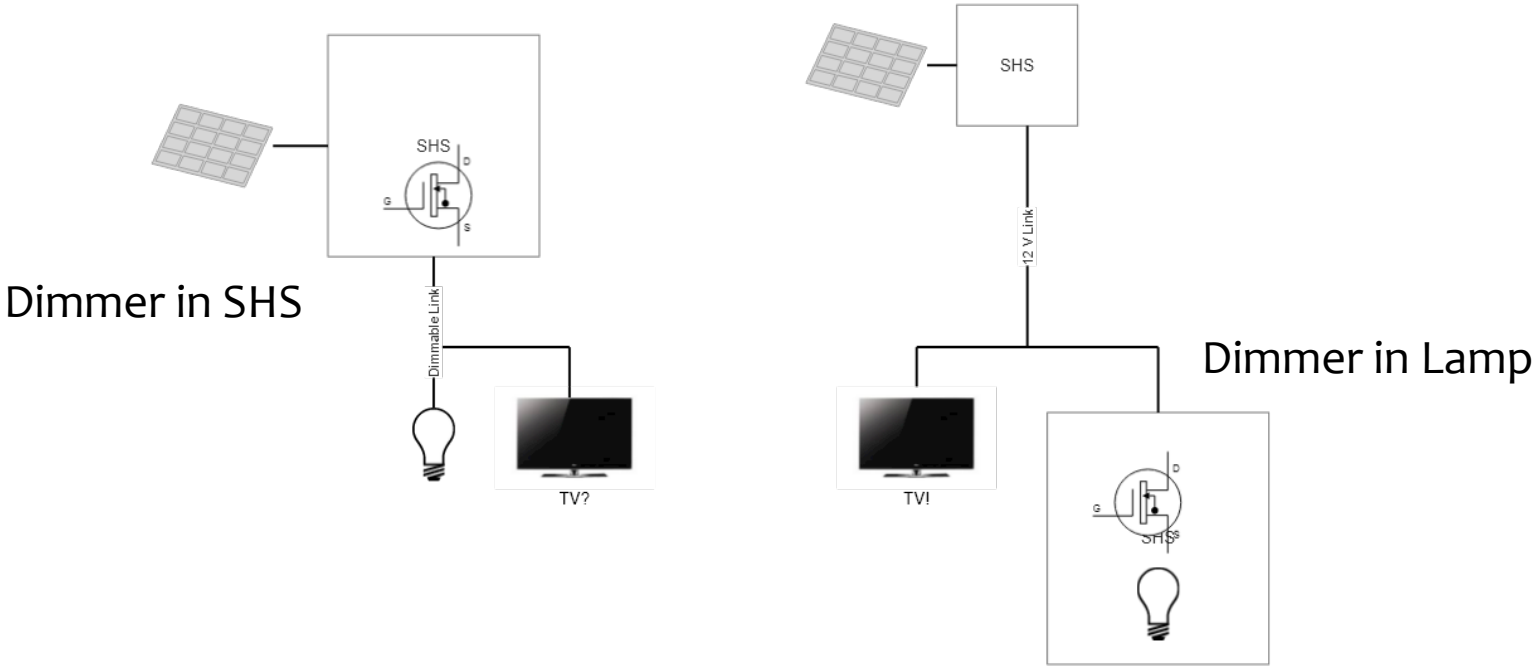
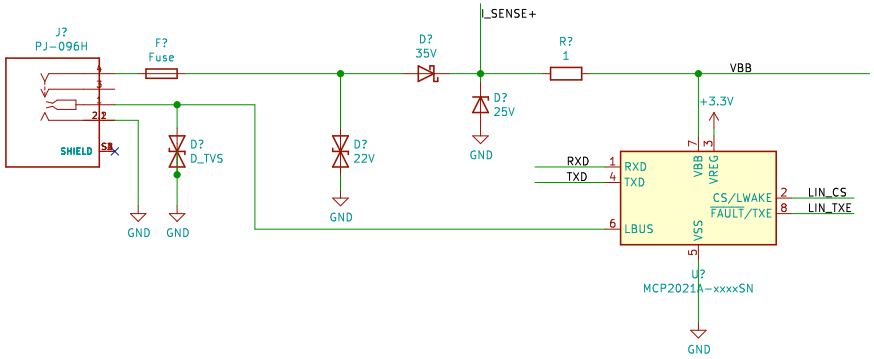


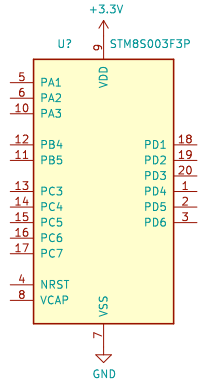
Figure 9. Bus Signal Thresholds for Receivers

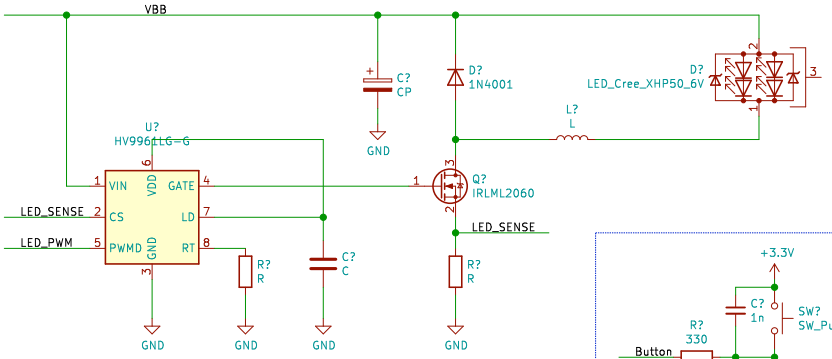
12V Link Example – Where does the Dimmer Go?

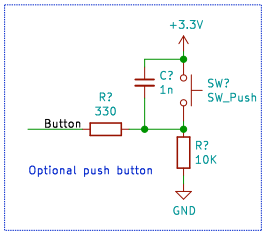


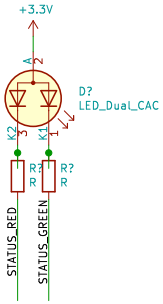
12V Link Example – Smart Light

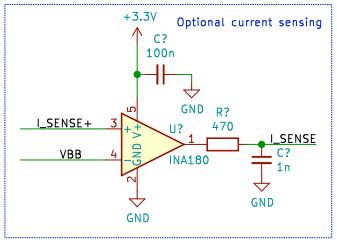












Communications - Applications

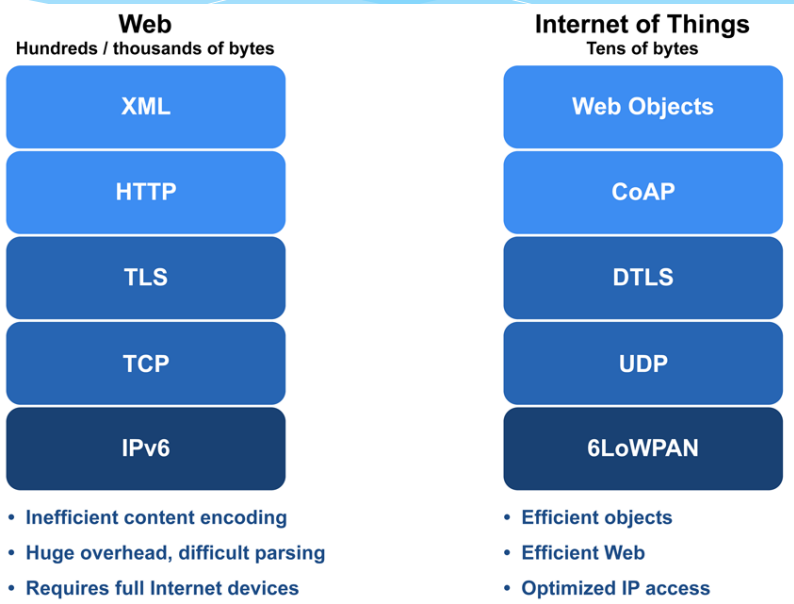
* Grid management
  * Route energy / power
  * Isolate faults
  * Grid configuration and monitoring
* Bus management
  * Allocate power from sources
  * Allocate power to loads
  * Sequence power on startup
* Device management
  * Device status - fridge temp
  * Device functions – dim a light
  * PAYGO – pass token

Communications - Constraints

* Cost
  * Common use cases very price sensitive
* Ease of use
  * Most functions must be plug and play
  * Minimal training
  * Tech support may not be available
* Security – as needed
  * Probably not needed for wired comm in home
  * Probably is needed between customers / wireless
* Interoperability – as needed
  * Many use cases have no Internet access
  * Businesses may need remote access to minimize travel
* Stability
  * Must preserve user investments – backwards compatibility
  * Potentially no opportunity for firmware upgrades
* Ease of implementation
  * Use existing open source code whenever possible
  * Easy to understand paradigms
  * Offer reference code
* Free Access
  * No patent licenses
  * Minimal dependence on purchased standards

Communications - Layers

* Multiple physical layers
  * ODGTalk for low cost
  * G3 PLC for long distance
  * CAN for performance
  * USB-PD, POE etc
* Routing only when needed
* Security only when needed
* Favor REST paradigm
  * CoAP with extensions



Communications – Presentation and Application

* Existing Models
  * Modbus etc – predefined registers with vendor extensions
  * ThingSet – JSON tree with CBOR, CoAP subset
  * Open Connectivity Foundation – JSON core
  * IEEE P2030.5 (SEP 2.0) – XML over CoAP
  * ISO etc etc
* Requirements (from ThingSet)
  * Flexible – independent of lower layer protocols
  * Compatible – easy to integrate with existing – CoAP etc
  * Human readable – text option
  * Compact footprint – code and message size
  * Schema-less and self explaining
  * Stateless
* Consistent mapping whenever practical

Related Standards / Industry Developments

* P2030.10
  * *Still* in review by PE/T&D
  * ODG has add unmanaged grid appendix to subsume P2030.10
* P2030.10.1
  * No recent activity
  * Meeting planned for Aug 8
* GOGLA Interop activities
* OpenPAYGO Token / OpenPAYGO Link

Next Meeting / Feedback

* Next Meeting
  * 11 August 2020 – 1400 UTC
  * FreeConferenceCall.com meeting ID: jlgula
* Sharing Portals
  * Web site: https://open-dc-grid.org/
  * GitHub: https://github.com/open-dc-grid
* Feedback?