WISHI

How to integrate IoT with Energy

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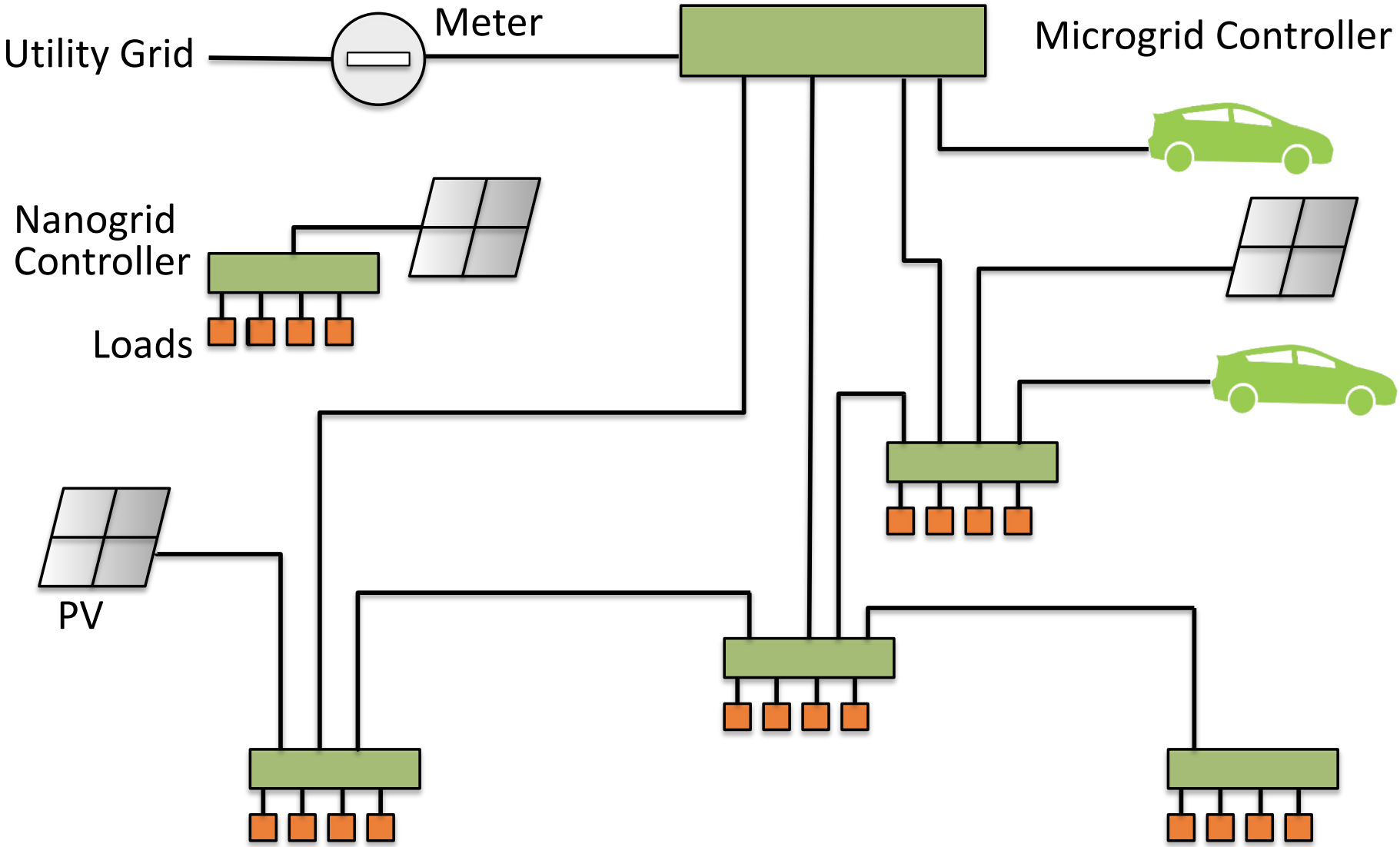
Early 2000s

- *Electronics on way to all being networked*
- *In long run, everything to be networked*
- *IT historically abstracted from physical world*

- What new architectural innovations/principles do we need as networking extends to physical-world devices?
- … with physicality in part that they consume energy?

Networked Electricity

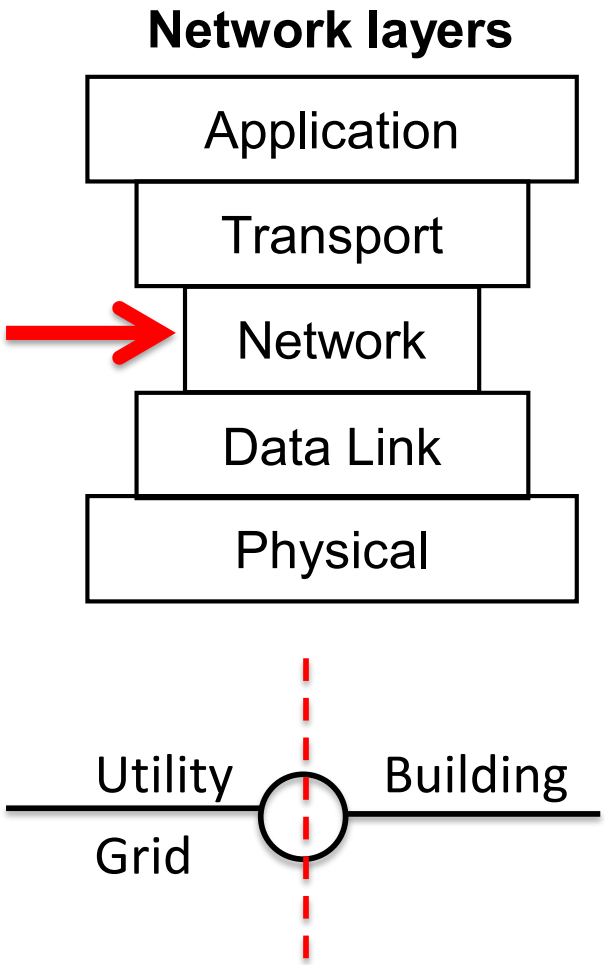
(Local Power Distribution)



All connections peer-to-peer and can be changed dynamically

Price is how devices know which way power should flow

Buildings need three Layered Models

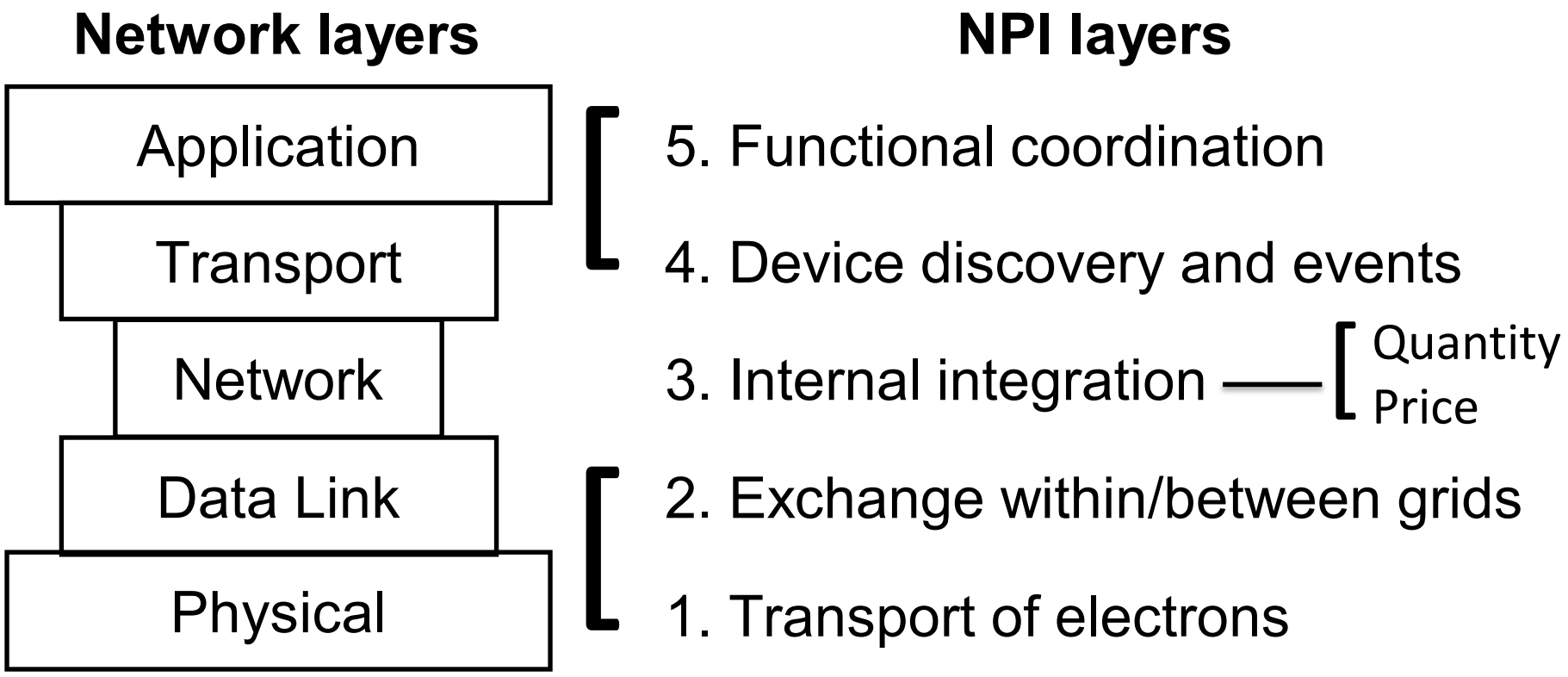


*Narrow waist in layering **isolates complexity** – facilitates interoperability*

- Conventional network communication
  - Application and physical layers
- Electricity / utility meter
  - Separate utility grid from building
  - "Highly dynamic pricing"
  - Use only Price, Quantity
  - Only 1-way communication
- Device internal Network Power Integration

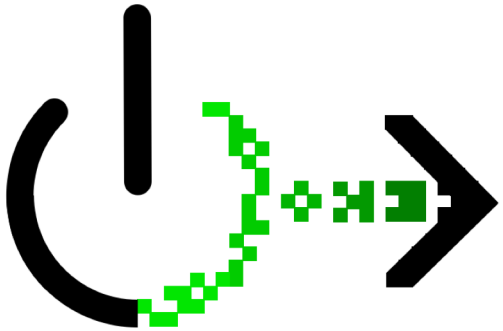
Layered model for device operation for Local Power Distribution

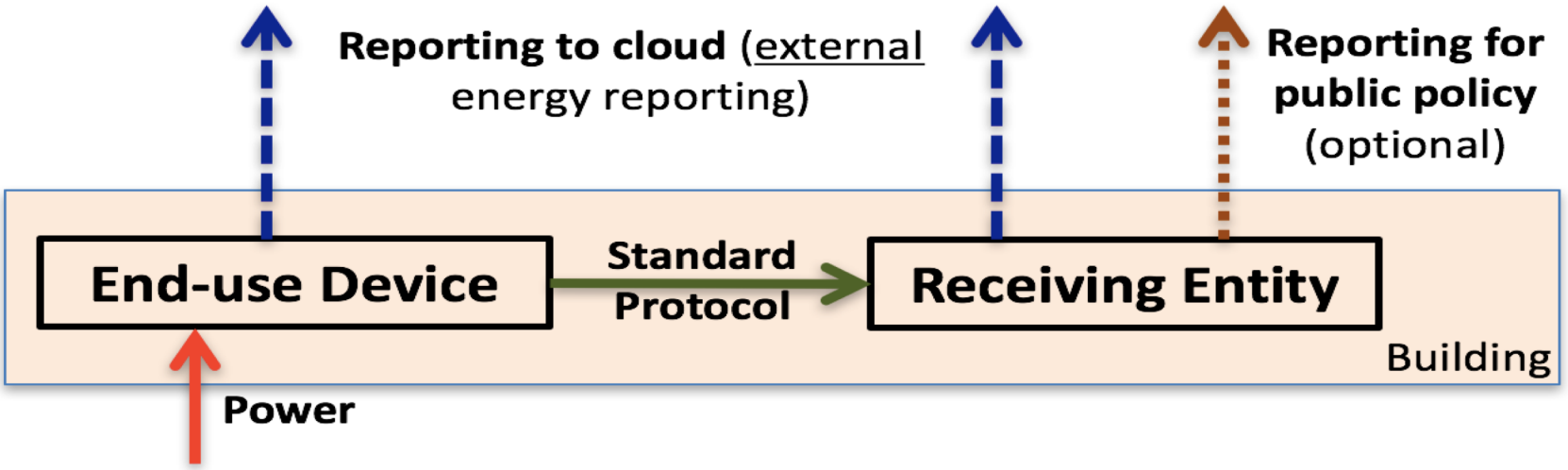
Network Power Integration



Topic 2: Energy Reporting

*The Principle that **All** devices should keep track of their own energy use and be able to report that, and related information, to the local network*





Data Model Issues – General Identity

Manufacturer

vendor-identifier (a 2-byte numeric value) and vendor-name (BACnet)
Vendor (FSGIM)
VendorName (MODbus)
Instrument/Manufacturer (sMAP)
Vendor name (VT)
ENERGY STAR Manufacturing Partner and Brand Name (ENERGY STAR)
Manufacturer and Make (BEDES)
Manufacturer (HPXML)
Manufacturer and Brand (NILM)
Manufacturer (XMPP)
Manufacturer (DMTF)
deviceManufacturer and deviceVendor (Haystack**)**
MakeModel (CTA 2047)

Model

model-name (BACnet, 70)
Model (FSGIM)
ModelName and ProductCode (MODbus)
Device model number (VT)
Instrument/Model (sMAP)
Model Name and Model Number (ENERGY STAR)
Model (DMF and VT)
ModelNumber (HPXML)
Model (NILM)
Brand and Product Line / Family Name (TPEx).
Name (XMPP)
***Also:* SKUs, UPC codes, retail numbers, descriptions, Global Trade Item Number and version UPC (Universal Product Code), Part Number, …**

(*Source*: Nordman and Cheung, 2015)

Proposed Reference Data Model

Item	Data Type	Comment
Units	Text	UCUM or IEEE 1451
Identification, Unique		
UUID	uuid	128 bits (16 bytes)
LocalIdentity	Text	list of “keyword=value;”
Identification, General		
EntityManufacturer	Text	name of Manufacturer, generally without suffix (e.g. Inc.)
EntityBrand	Text	name of Brand if different from manufacturer, otherwise empty
EntityModel	Text	model number/name
EntityIdentityGeneral	Text	list of “keyword=value;”
EntityURL	Text	
DeviceType	Enumeration (0..92)	Universal Device Classification, B. Nordman and H.Y. Cheung, 2013.
Local Data		
LocalName	Text	Locally-determined name
LocalOtherInfo	Text	list of “keyword=value;”
Location		
LocationLocal	Text	list of “keyword=value;”
Power State	Enumeration (0..5)	
Energy Reporting		
PowerLevel	Float	current electrical power in W
CumulativeEnergy	Float	accumulated energy use in Wh
TimeStamp	Float or text	Unix time or RFC 3339 time

Thank you