



Connected Central AC/Air Source Heat Pump and Water Heaters Working Session



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Phoenix, AZ
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Working With Stakeholders Since 2011



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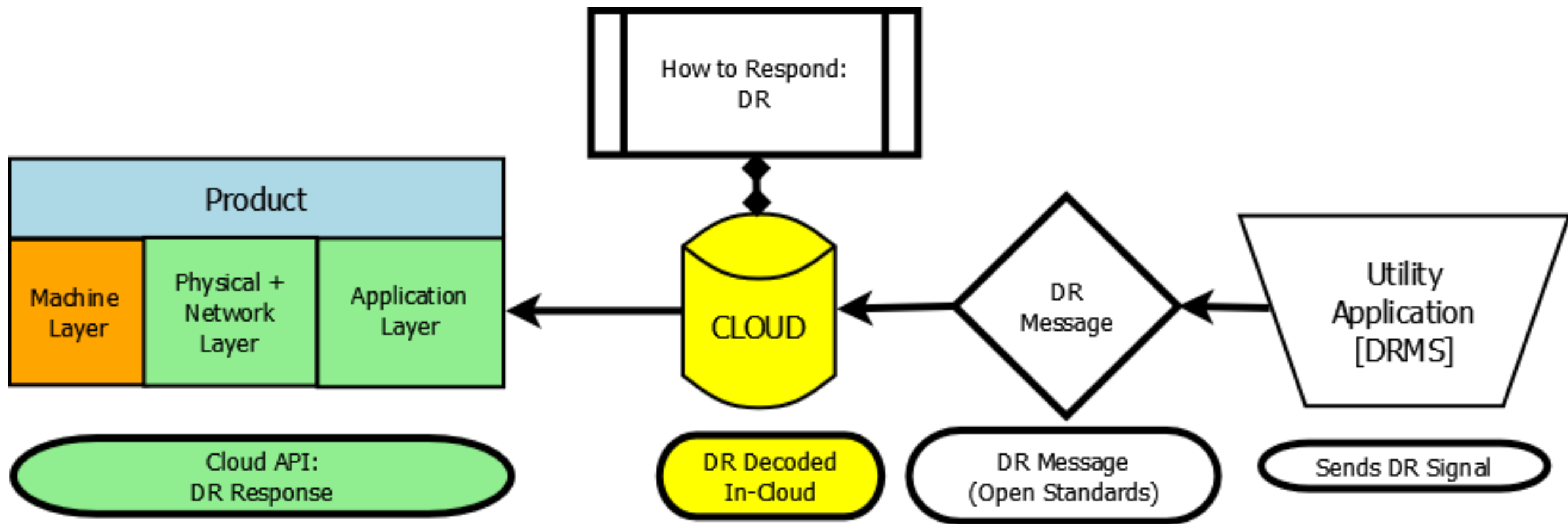
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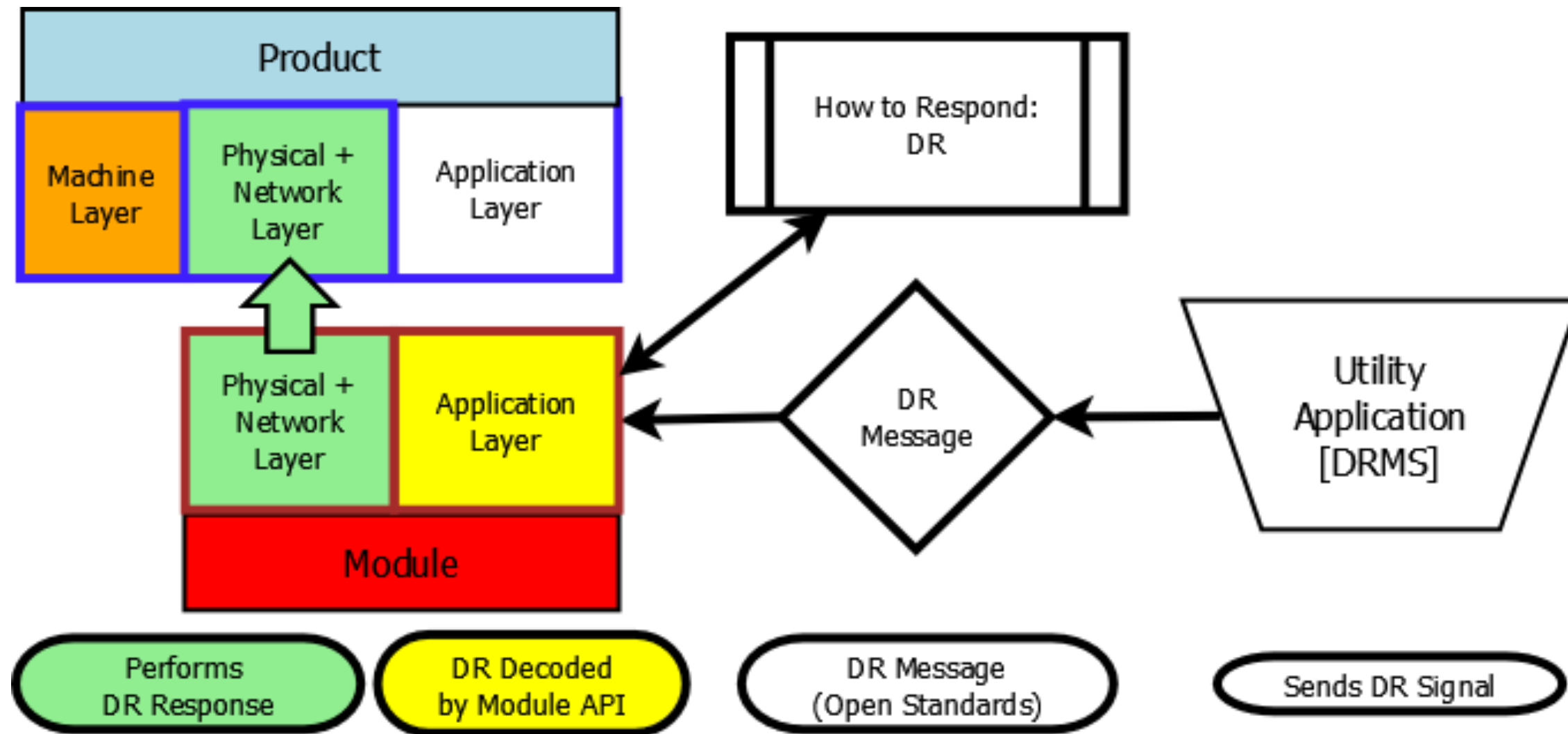


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Communications Architecture: DR in the Cloud



Communications Architecture: DR in a Module





Translating in the Cloud

- Pros:
 - Reconfigurable while DR response of product(s) in development
 - More flexible for different incoming utility application layers
 - Less hardware/firmware needed at the device
 - Cloud API is DR protocol security endpoint
- Cons:
 - Short term inaccessibility: home WiFi down time, broadband service down time
 - Long term inaccessibility: obsolescence/backwards compatibility, software updates, product provider business model change



Translating on Site (Module/Product)

- Pros:
 - Reliable access to device
 - Plug & play: turnkey modules/chips & ecosystem
 - Could match module/hardware with utility system
- Cons:
 - More powerful hardware needed in the device
 - Hardware obsolescence
 - Device is DR protocol security endpoint



Stakeholder Interests

- Utilities and aggregators want
 - To invest in load flexibility that will be available even if a manufacturer decides to get out of the (very volatile) DR business
 - To minimize the number of entities they need to arrange separate agreements with to allow them to send DR requests to products
- Manufacturers want
 - Users to have a good experience with their product
 - To maintain access to connected products for their own purposes



EPA has a dog in the fight too. We want...

- Interoperable products, to minimize consumer confusion and frustration
- Consumers to get immediate value from connected products, aside from any theoretical advantage from participating in DR programs
- To support the deployment of products with DR capability, to facilitate intermittent renewables
 - Manufacturers find it worthwhile to provide products that meet ENERGY STAR criteria
 - Utilities and aggregators specify ENERGY STAR products
- Maximum flexibility for the market to be able to explore various solutions



How this has shown up in specifications

- EPA specifications
 - Require the use of open protocols and/or provision of interface control documentation
 - Encourage, but do not require, open standards on premises
 - Allow, but do not require, the use of modules
- CEE and NEEA specifications
 - Quite similar, but...
 - Require use of CTA 2045 or similar interface
- Manufacturers providing connected products
 - Many do not meet the ENERGY STAR criteria
 - Most provided for consumer amenity, not for grid benefit



Connected Thermostats as Case Study

- DR requirements in ENERGY STAR specification are very general
 - Some CT service providers already acting as aggregators when specification was finalized
 - Others provide device level control to utilities
- DR opportunity ripe enough to be in active use despite technical and business case barriers very similar to those discussed above
 - Some utilities running “Bring Your Own Device” programs, where users with a wide range of thermostats can sign them up
 - Others working with service providers to offer customers an end-to-end solution



Different products' drivers and opportunities

Type	Driver of market adoption	Energy Implication and/or Opportunity	Examples
Large loads, load flexibility doesn't impact consumer	Grid services	Enable cleaner grid	Pool pumps, water heaters
Large loads, load flexibility can impact consumer	Grid services	Enable cleaner grid; protect consumer interest	EVSE, HVAC
Convenience and quality of maintenance	Consumer and brand owner interest	Better maintenance saves energy	White goods, HVAC
Safety and security	Consumer interest	Added load; may provide occupancy info	Door locks, window sensors
Additional functionality	Consumer interest	Added load	Color changing lights, smart speakers



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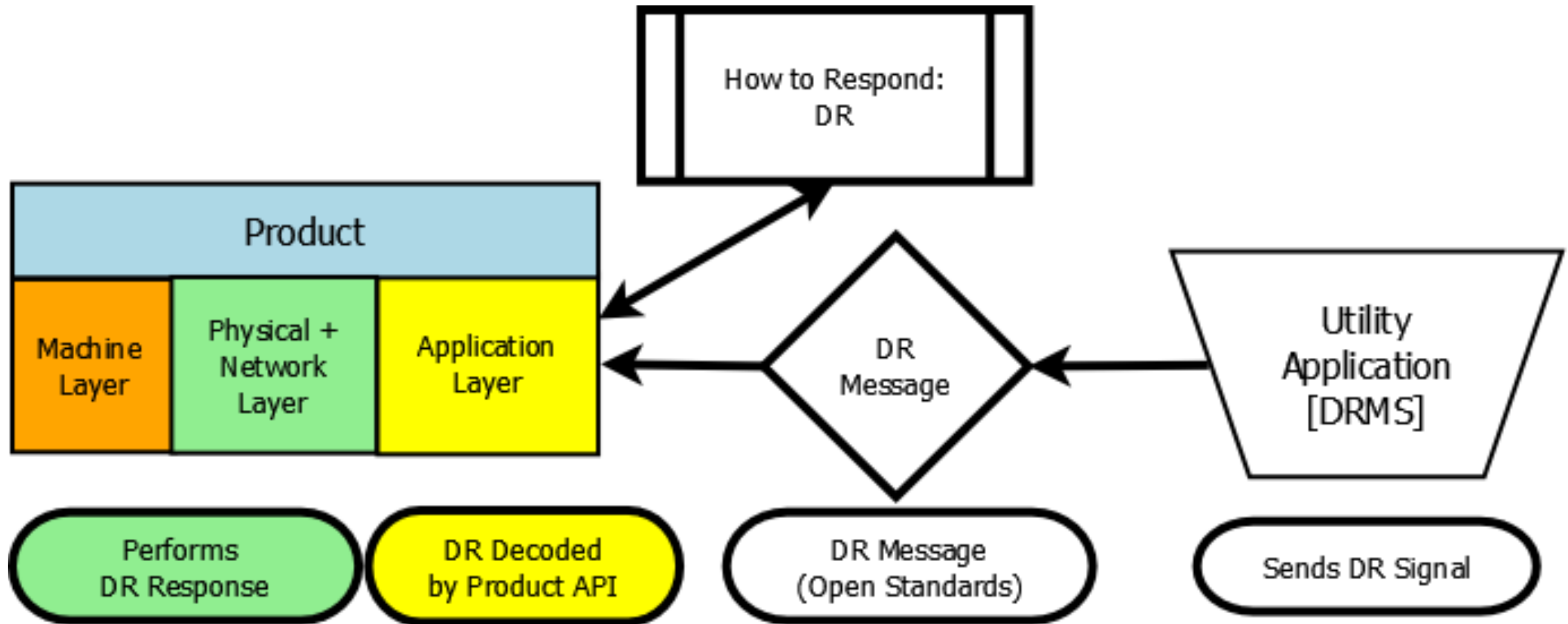


Prologue: Standardized Messaging (Pool Pumps)

Table 5: CTA Op State Codes (Table 8.2.4)⁴

Op State Code	Name	Section 4.4 Corresponding Item	Description
0	Idle Normal	Off/Standby	Indicates that no demand response event is in effect and the CPPD has no/insignificant energy consumption.
1	Running Normal	On	Indicates that no demand response event is in effect and the CPPD has significant energy consumption.
2	Running Curtailed	Active Type 1 or Active Type 2; Pump Running	Indicates that a curtailment type demand response event is in effect and the CPPD has significant energy consumption.
3	Running Heightened	Active Type 3; Pump Running	Indicates that a heightened-operation type of demand response event is in effect and the CPPD has significant energy consumption.
4	Idle Curtailed	Active Type 1 or Active Type 2; Pump Not Running	Indicates that a curtailment type demand response event is in effect and the CPPD has no/insignificant energy consumption.
5	CPPD Error Condition	Messages (4.4 B)	Indicates that the CPPD is not operating because it needs maintenance support or is in some way disabled (i.e. no response to the grid).
6	Idle Heightened	Active Type 3; Pump Not Running	Indicates that a heightened-operation type of demand response event is in effect and the CPPD has no/insignificant energy consumption.
9	Variable Following	(No Entry)	Indicates that a variable-setting type of demand response event is in effect and the CPPD is presently following the specified setting.
10	Variable Not Following	(No Entry)	Indicates that a variable-setting type demand response event is in effect and the CPPD is presently not following the specified setting (e.g. has no/insignificant energy consumption).
11	Idle, Opted Out	Timestamped DR Over-ride Notification; Off/Standby	Indicates that the CPPD is presently opted out of any demand response events and the CPPD has no/insignificant energy consumption.
12	Running, Opted Out	Timestamped DR Over-ride Notification; On	Indicates that the CPPD is presently opted out of any demand response events and the CPPD has significant energy consumption.
13:125	Not Used	(No Entry)	Future use
126:255	Reserved	(No Entry)	Reserved for manufacturer use.

Communications Architecture: DR in the Product





More prologue: AHRI 1380

- Goal: To establish requirements for variable capacity HVAC systems supporting DR in a predictable manner.
 - Complex equipment (e.g., modulating) is too flexible to align responses across manufacturers/products naturally.
 - For example, which % capacity to use on Curtailment I (low)?
 - This can unify input/output/response across application layer standards
 - CTA, ADR, SEP, Others
- AHRI 1380 working through AHRI process to reach a draft to be released for public comment – AHRI able to comment further?



More about what this would mean

- Specification would include a table of responses to standard commands (or would refer to a table in a separate standard)
- Specification would not require a particular standard on other layers



More prologue: meeting at ACEEE hot water forum

- EPA held a discussion on connected water heaters and ENERGY STAR with manufacturers, Partners, stakeholder, utilities, etc. at the 2018 ACEEE Hot Water Forum
- Presentations from EPA, NRDC, Aquanta, EPRI, NRECA, NEEA, and CEE
 - Cost effective load shifting of heat pump water heaters
 - Grid interaction strategies
 - Communication interfaces
 - Other connected water heater specifications
- Some sticky issues still up for discussion since the hot water forum

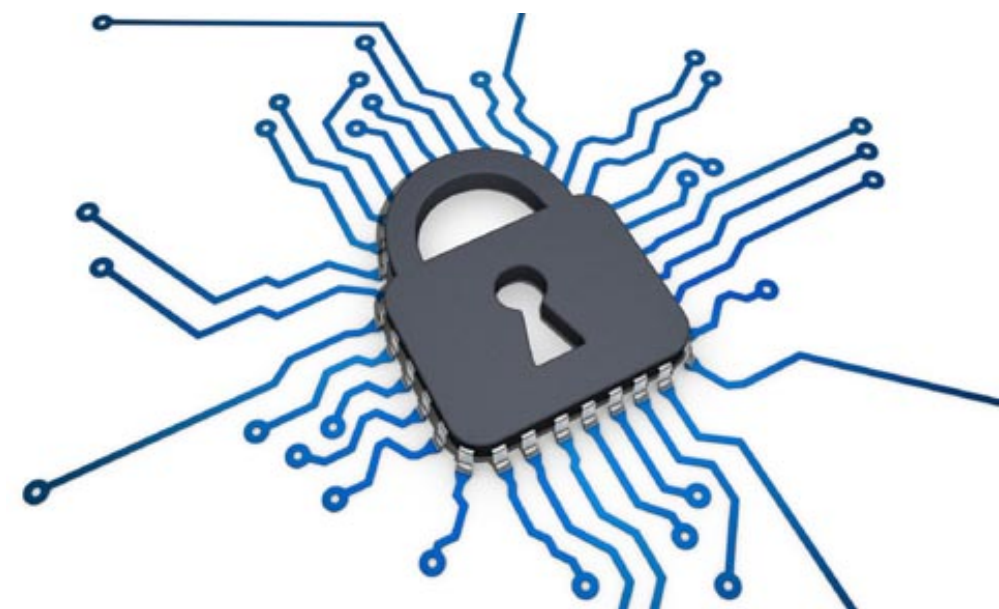


Stakeholder Discussions since the Hot Water Forum

- Manufacturers' visions about how to pursue connected, grid aware water heaters differ
- Some manufacturers want a similar way to connect across range of product they produce
- Manufacturers largely want benefits of connected water heaters to be immediate to the customer
- Security is of concern for all – EPA is not leading any efforts in standards development for connected product security

A Quick Note on Security

EPA understands there can be security risks associated with smart products and systems. Recognizing that this is not our area of expertise, we do not intend to take the lead on developing security standards in the smart home market. To the extent that sound security standards arise, EPA may point to them in ENERGY STAR specifications as appropriate.



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Questions to address

- Required that unit meets the criteria, or unit + controller?
- Why does the system need a cloud connection to respond to a grid request?
- Advantages of local response
- What is the role of application layer protocols in making a system secure?



Open Discussion

- Comments or questions on any part of today's session?
- Additional topics of interest or concern regarding this topic?



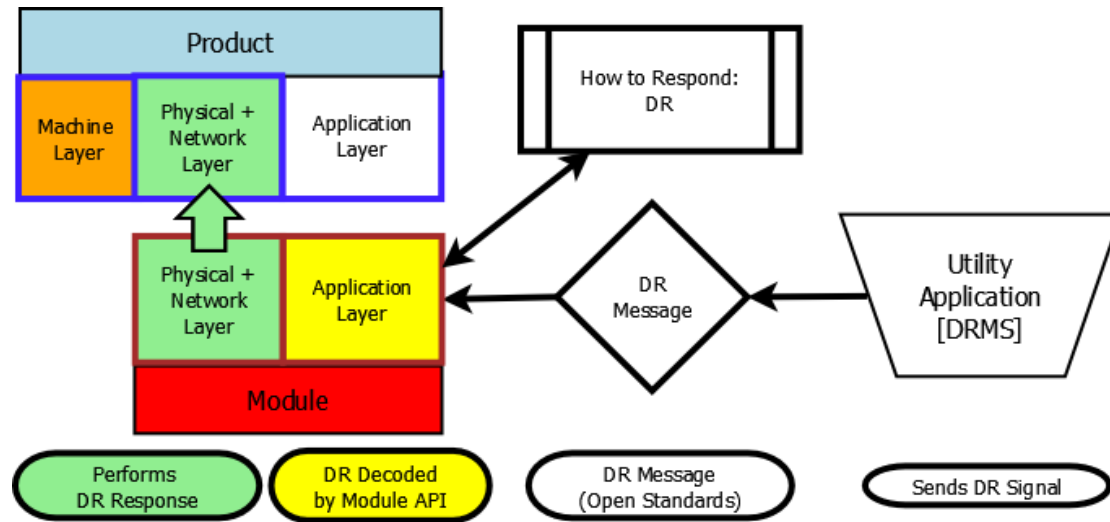
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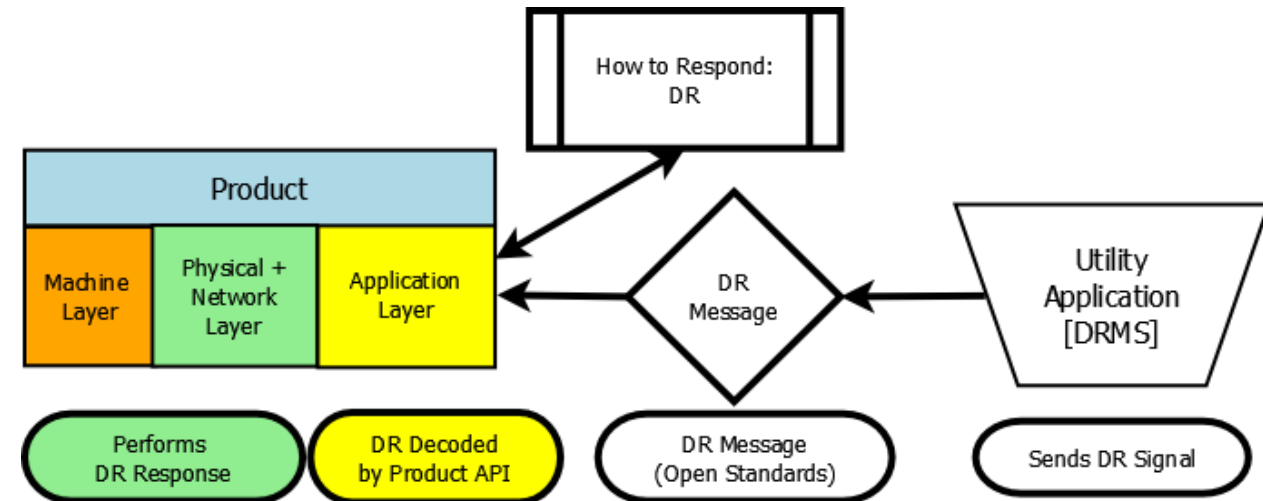


Communications Architecture Comparison

Decoding in a DR Module



Decoding in the Product



Decoding in the Cloud

