U.S. Department of ENERGY | Office of Energy Efficiency & Renewable Energy

Building Technologies Office

# The Three Sides of Digital Standards

Amir Roth

US DOE Building Technologies Office

CalBEM

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# DIGITAL STANDARDS

## Digital world is highly standardized

- Hardware interfaces and ABIs: x86_64, USB
- Programming languages: C++, Python, JavaScript
- Communication protocols: Ethernet, Wifi, Bluetooth, TCP/IP, SSH, SMS, HTTP, SMAP
- Data: JSON/CBOR, PDF, MP3, JPEG, MPEG

## Standardization enabled the digital world to grow

- Stable connection points for new entrants and for adjacent industries

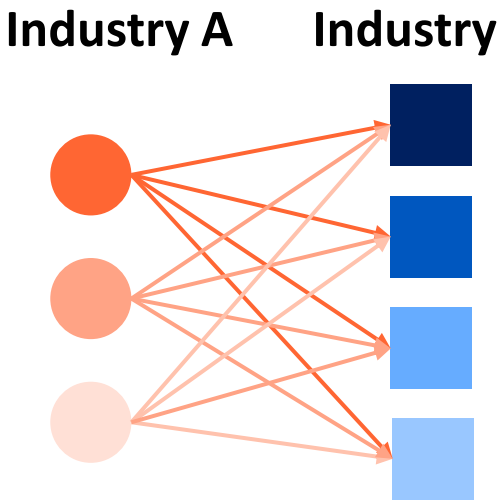
## Has also created some challenges

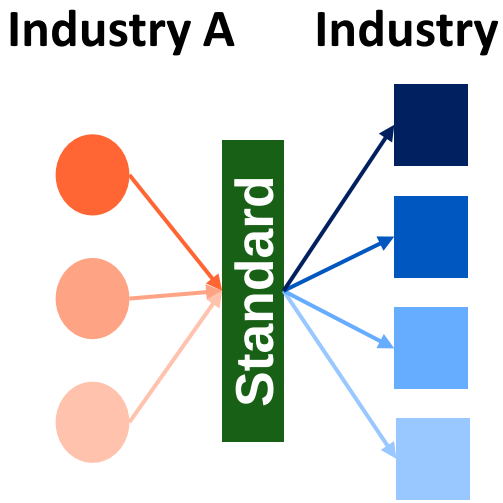
- Privacy, IP, some business models have become less viable

**BEM industry is not really standardized … but probably should be**

- Clear benefits
- Challenges can be overcome

# DIGITAL STANDARDS HELP INDUSTRIES GROW

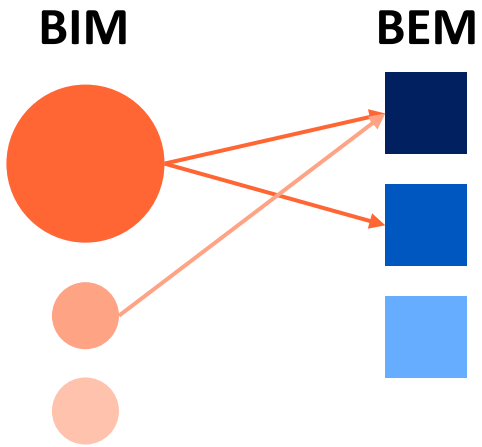



## Digital standards → interoperability → scalability

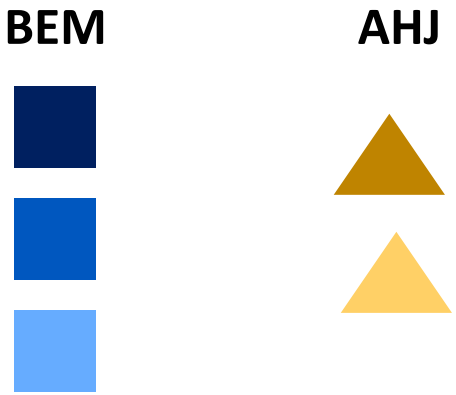
- At “boundaries” between industries … or different “layers” in the same industry
- Reduce the cost (and increases the value) of connecting across industries
- Eliminate need for explicit vendor-to-vendor relationships

# SOME (COUNTER) EXAMPLES




## BIM

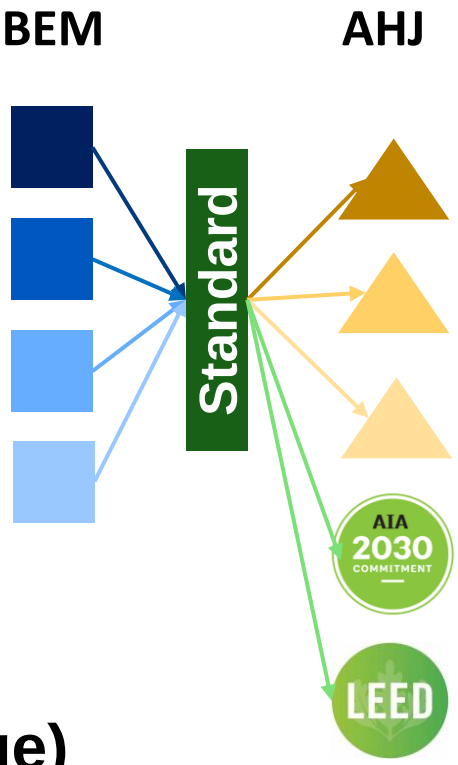
- BIM-to-BEM is still “unsolved” industry-wide in part due to a lack of standardization at this interface




## Code Review

- Performance-path is not widely used, review rigor/bandwidth is one factor
- BEM output standards would reduce cognitive burden on reviewers
- Standardization would simplify reporting and tracking by AHJs
- IBPSA-USA Building Data Exchange (BDE)
- ASHRAE 229P

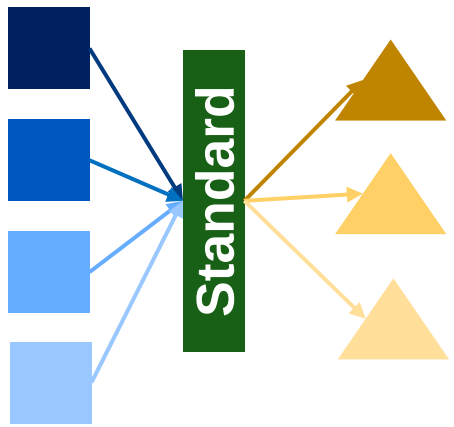
# WHAT IS BDE?

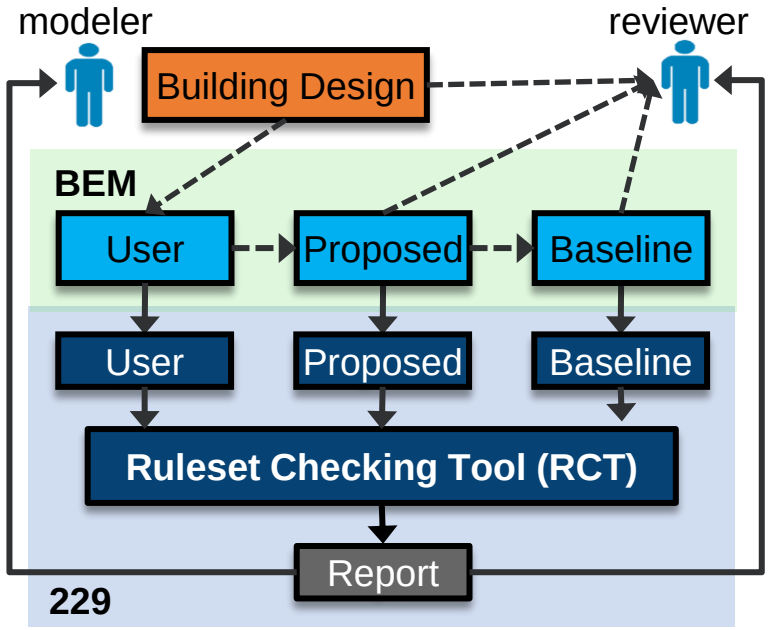



## BDE (Building Data Exchange)

- Schema for common simulation outputs
- Complements vendor specific reports
- Applications to reporting programs (compliance, LEED, AIA 2030, 179D, etc.)

# WHAT IS ASHRAE 229P?

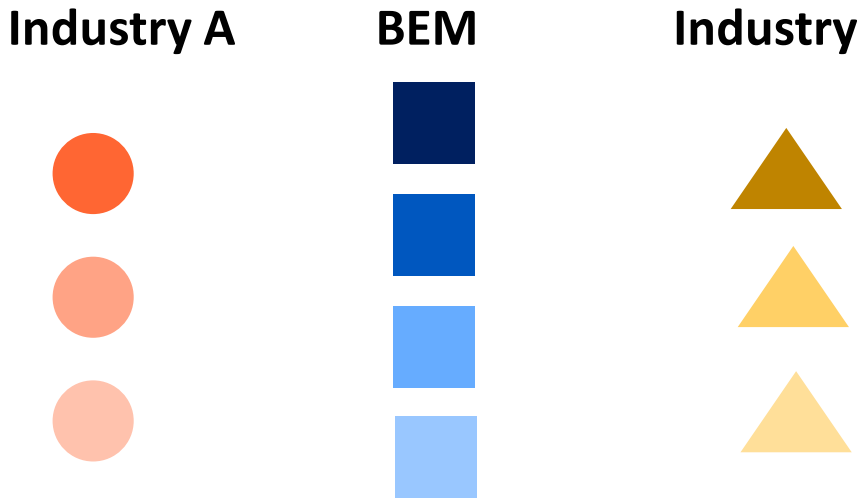



## ASHRAE 229P "Evaluating Ruleset Application to Simulation Models"

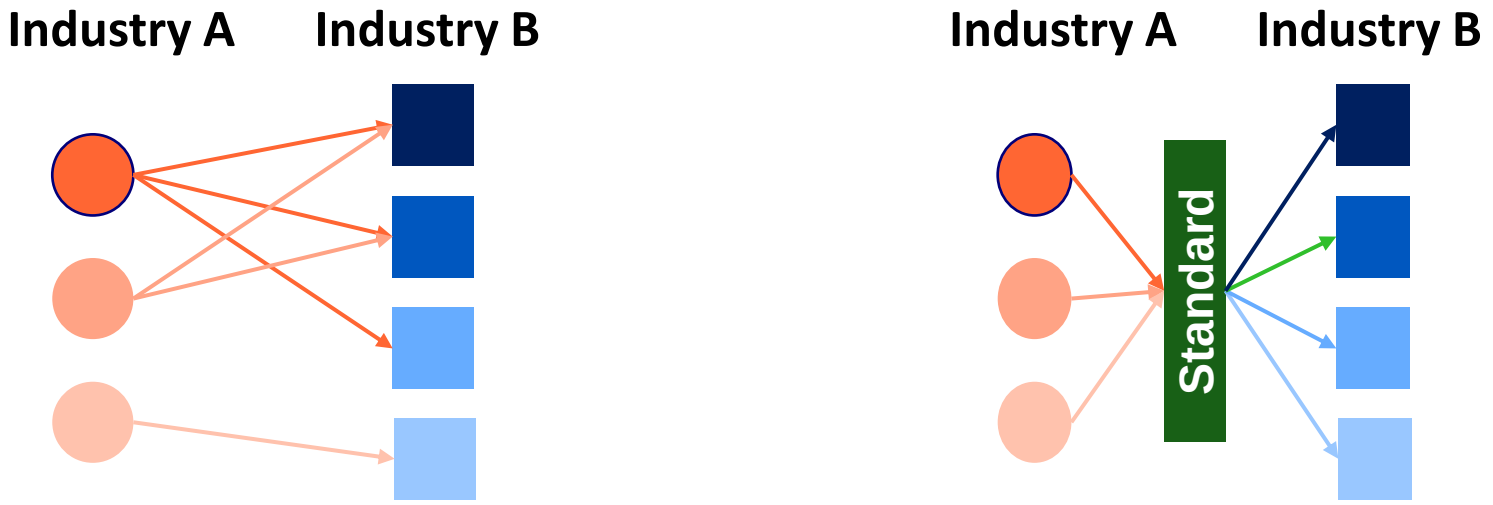
- Intended to improve rigor, transparency, and consistency of model review
- … and encourage adoption of performance-based codes and performance-path compliance
- BEM engines export model description (RES) at "ruleset" (e.g., 90.1 AppG) level of detail
- Checker (RCT) checks that proposed/baseline RES pairs have right relationship
- Complements BDE

# WHAT OTHER INDUSTRIES SHOULD BEM CONNECT TO?




- HVAC OEMs ← ASHRAE 205
- Control engineers, Commissioning agents, Operators ← ASHRAE 223P, 231P
- Who else?

# DIGITAL STANDARDS ENABLE COMPETITION




**Industry A actors compete to produce data for industry B**

**Industry B actors may compete for users**

- If all (or even most) necessary inputs are standardized

**This is just competition, not a challenge to IP or business models**

# DIGITAL DATA CHALLENGES IP, PRIVACY, BUSINESS MODELS

## Example: non-TMY weather files

- Once sold to someone, may be difficult to sell the same file to someone else**

## Example: ASHRAE 205 detailed equipment performance data files

- Issue is not monetization, just straight IP

## Example: ASHRAE 229P RES files

- Detailed enough to act as input for another BEM tool → vendors may be reluctant to export

**"Making bits not copyable is like making water not wet" –anon

# ENCRYPTION (ALONE) IS NOT A SOLUTION

```
(lldb) x/1000b --force 0x0000000112882000
0x112882000: Schedule:Constant,\n  Actuated Sc
0x112882020: hedule Direct,                !-
0x112882040: Name\n  ,
0x112882060:                !- Schedule Type
0x112882080: Limits Name\n  18;
0x1128820a0:                          !- Hourly
0x1128820c0: Value\nSchedule:Constant,\n  Actua
0x1128820e0: ted Schedule Indirect,
0x112882100:    !- Name\n  ,
0x112882120:                         !- Schedule
0x112882140:  Type Limits Name\n  18;
0x112882160:                                !- H
0x112882180: ourly Value\nEnergyManagementSyst
0x1128821a0: em:GlobalVariable,\n  argTrendVal
0x1128821c0: ue,                            !-
0x1128821e0: Erl Variable Name 1\n  resultValu
0x112882200: e1;                             !-
0x112882220:  Erl Variable Name 2\nEnergyManag
0x112882240: ementSystem:TrendVariable,\n  Tre
0x112882260: nd_argTrendValue,
0x112882280:      !- Name\n  argTrendValue,
0x1128822a0:                          !- EMS Va
0x1128822c0: riable Name\n  12;
0x1128822e0:                          !- Number
```

**Tools have to decrypt files before using them**

- Can get clear text even if tool itself is proprietary
- Open up tool in debugger and do a memory dump
- Example: EnergyPlus

**“There is no such thing as a temporarily decrypted file or an embedded decrypted file. If a file is decrypted in the memory of a user’s machine, she can always make a permanent copy of the cleartext.”**

# CLOUD-BASED SERVICES

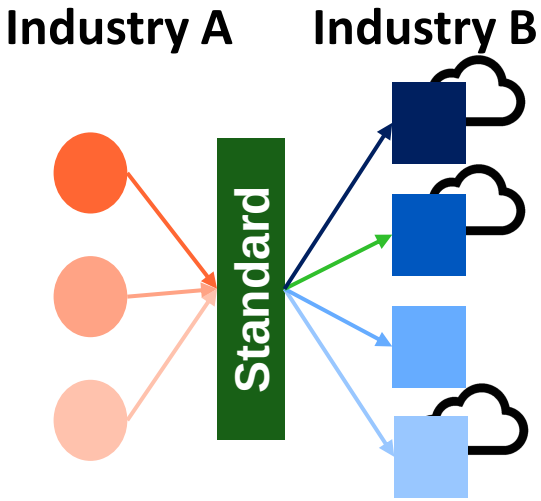
**Many companies have moved software to the cloud (many others started there) …**

**Many reasons for doing this …**

- Use subscription vs. one-time fee model
- Eliminate bootleg copies of your own software
- Gather more data about your users
- Spend less on user installation/configuration support
- Leverage elastic storage and compute capabilities

**Ability to protect sensitive data for monetary, IP, or other reasons**

# WHOSE CLOUD?




**Conceptually easy if one vendor supplies the software and all (sensitive) inputs**

**What if sensitive inputs come from other vendors? From multiple vendors?**

- E.g., you want to run BEM tool X with weather file from W and 205 files from Y and Z …
- Whose cloud should the simulation run on? BEM vendor X, weather vendor W, OEMs Y or Z?
- Probably BEM vendor X … or maybe a third-party provider that specializes in such things

# HOW DOES EVERYONE ELSE GET THEIR MONEY?

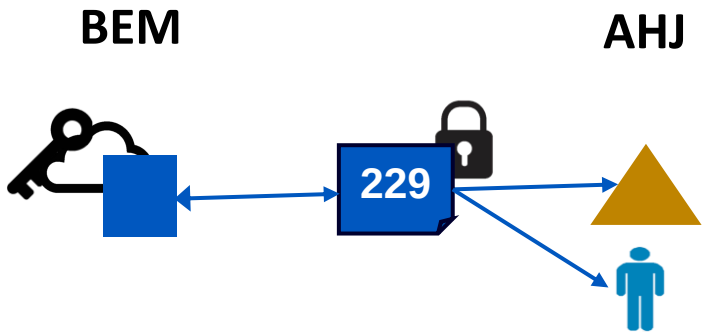

**How do W, Y, and Z monetize their data and/or ensure it isn't leaked or misused?**

- Option 1: W, Y, Z have a legal agreement with X to host their data and provide it to X's users
- Option 2: W, Y, Z can sell encrypted files to users which only X can decrypt
  - W, Y, and Z can have direct relationships with customers**
  - Requires a legal agreement with X to not misuse the cleartext
- Other variants possible depending on the use case

**Can give user encrypted file for chain-of-custody … just don't give decryption key**

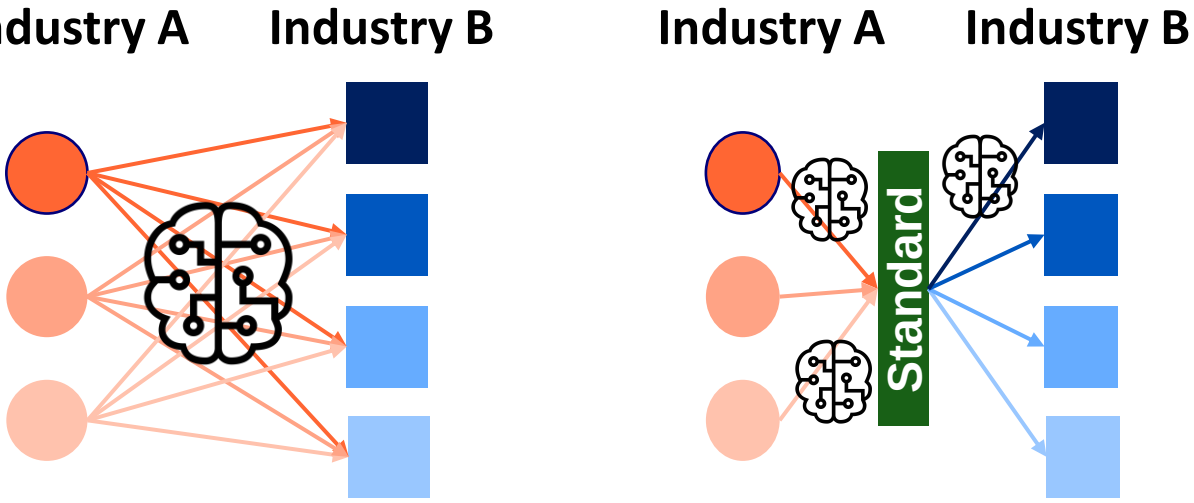
- This works because of asymmetric (i.e., public-key) cryptography

# ANOTHER EXAMPLE




This one doesn’t even require asymmetric cryptography

# WHAT ABOUT AI? PART I



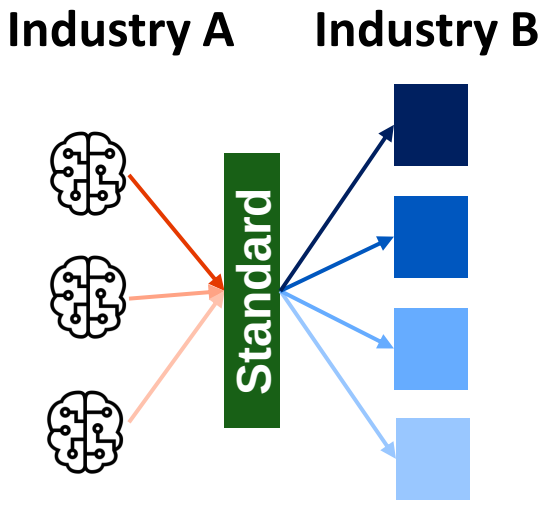

**Generative AI lowers the cost of point-to-point translations …**

**Does this make standards obsolete?**

- Maybe, but AI translations will not be as reliable/deterministic as hand-coded ones (for a while)
- AI also reduces the cost of translating to a standard (with same reliability issues)
  - A standard allows vendors to train/debug their translations independently

**Ultimately, you want a "white-box" common representation**

# WHAT ABOUT AI? PART II




**AI is not just a mediator/translator between adjacent industries**

**AI is itself an adjacent industry to every other industry**

- Where can AI help BEM?
- What do we want AI do know about BEM as a whole?
- Do we want a BEM “foundation model”? How do we make one?
- How can we standardize the BEM/AI data boundary to help AI help BEM?

# TL;DR

## BEM industry would benefit from additional digital standardization

- Especially at the interfaces with other industries

## Digital exchange presents challenges to privacy, IP, business models

- But these can be handled by controlling where software executes (e.g., the cloud)

## AI doesn’t make need for standardization go away

- Want common language of BEM to be one that we created and that we understand
- Want to standardize BEM’s interface to AI so that AI understands BEM better

**Thank you!**

amir.roth@ee.doe.gov

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