Wind Power Forecasting Data Definitions and Exchange Standards –

An Approach for a Recommended Practice Built Upon International Standards and an Eye Towards the Future

19th Wind Integration Workshop

Session 6A: IEA Wind Task 36

12 November 2020

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Wind Power Forecasting Data Definitions and Exchange Standards :: Outline

- IEA Task 36, Work Package 2, Subtask 2.4
- Statement of the problem
- Current practices
- What standards exist today?
- Examples
- Current thinking and approach
- Future work and how to participate

What is IEA Task 36 Work Package 2?

Power and Uncertainty Forecasting:

Separated into four sub-tasks:

1. Update of the IEA Recommended Practice on Forecast Solution Selection, including benchmarking.
2. Uncovering uncertainty origins and development through the whole modelling chain.
3. Set-up and dissemination of benchmark test cases and data sets
4. Collaboration on standardization with IEC, discussion of standardization needs for forecast vendor / user interaction

Objectives and description of effort:
https://www.ieawindforecasting.dk/work-packages/workpackage-2

Wind Power Forecasting Data Definitions and Exchange Standards – *Statement of the Problem*

Forecast providers and consumers spend <u>excessive</u> time in the set up process for trials and new forecasts

1. ***Terminology*** - providers use different nomenclature than consumers resulting in excess back-and-forth communication
2. ***Definitions*** - misunderstanding the meta-, historical- or realtime-data parameter definitions
3. ***Translation*** - consumers must research then map SCADA and EMS software documentation to provider's requested data
4. ***Software development*** - providers *or* consumers must develop custom scripts to reformat data into pre-existing, non-standard format

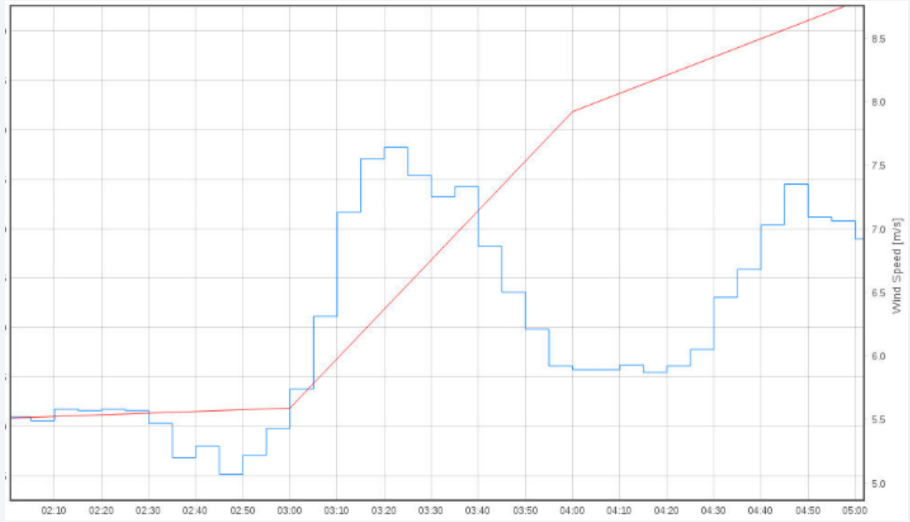
Ultimately, cost of integrating renewable energy can be reduced by minimizing resources spent on redundant communication, education, or software development

Wind Power Forecasting Data Definitions and Exchange Standards – *Statement of the Problem*

Example –

How would you succinctly and effectively describe in words the ***time series date-time interval***?

- Is it indicating the leading- or ending-period?
- Is it the instantaneous or an average value?
- Should the resolution of the interval be articulated the same for measurement and forecast time series?



Enumeration and examples of the product type help define the parameter, but a common information model is required.....

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Wind Power Forecasting Data Definitions and Exchange Standards – *What Standards or Best Practices Exist Today?*

Organization/Effort	Strengths	Weaknesses
ENTSO-E: Weather process and energy prognosis implementation guide	• Extensible and adaptable core set of information model definitions in UML • Uses IEC standard 62325-450 : energy market communications • Conforms to the Common Information Model (CIM) • Already in use by some European TSOs	• Data definitions are not explicit (beyond scope of CIM) • Not practical for smaller forecast users to implement (IT overhead costs) • CIM documentation must be paid for (!?)
IEC 61400-12/25: Power performance of wind turbines and communications	• Great model to follow for establishing wind energy industry standard	• Not applicable to renewable energy forecasting (for resource assessment) • Changes take months to years for approval/implementation
IEA Recommended Practice for Selecting Renewable Power Forecasting Solutions	• Applicable to energy forecasting • Provides guidelines for metadata, sample schemas for data exchange, and some data definitions	• Lacks details on data structure, definition and units • No link or reference to existing standards (e.g., IEC, ETSI)

Wind Power Forecasting Data Definitions and Exchange Standards – *What Standards or Best Practices Exist Today?*

Organization/Effort	Strengths	Weaknesses
DOE SFIP2: Open Source Evaluation Framework for Solar Forecasting ("Solar Arbiter")	• API framework for data format and exchange • Applicable to energy forecasting • Extensible to wind • Publicly available (open source) • Well documented and easy to understand	• Continued support and maintenance beyond current funding cycle is uncertain • Data model not mapped to existing standards
SAREF ontology: Smart Appliances REFerence)	• Uses ETSI and EU industry standards for demand-response energy communications • Highly extensible – forward looking • "Interconnect" project funding includes grid interoperability and energy management	• Data definitions are not explicit (abstracted model similar to IEC 62325) • Not as known in the utility, ISO/TSO space • Geared for distributed generation currently
ENTR Alliance: Open Data Standards organization of wind owner-operators	• Being promoted by forecast end users • Trying to solve same issues as forecast providers (non-standard data definitions) • Support from some large developers and SCADA Intl.	• New initiative mostly based in US

Enumeration and examples of the product type help define the parameter, but a common information model addresses the need for a standard data exchange method…

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Wind Power Forecasting Data Definitions and Exchange Standards – *Data Model Example*

Example 1: ENTSO-E Weather process and energy prognosis – implementation guide (2017)

Table 1 – Weather configuration document dependency table

Attribute	Value
WeatherConfiguration_MarketDocument	
Type	A95 = Configuration document
sender_MarketParticipant.marketRole.type	A04 = System operator
receiver_MarketParticipant.marketRole.type	A43 = Weather analyser
status	A14 = Creation A15 = Update Note: a document may be either a creation or an update.
Location	
mRID	The identification of the location being described.
coordinateSystem.mRID	A01 = ED50 A02 = OSGB36 A03 = WGS84 A04 = GTRF Refer to ENTSO-E code list for having more description about coordinate syst
start_DateAndOrTime.date Date	The date that the regi tional
end_DateAndOrTime.date Date	The date that the regi sioned.
positionPoints.xPosition	Latitude
positionPoints.yPosition	Longitude
positionPoints.zPosition	Altitude

Attribute type and value maps to codelist definition document

Table 9 - Codelist CoordinateSystemType

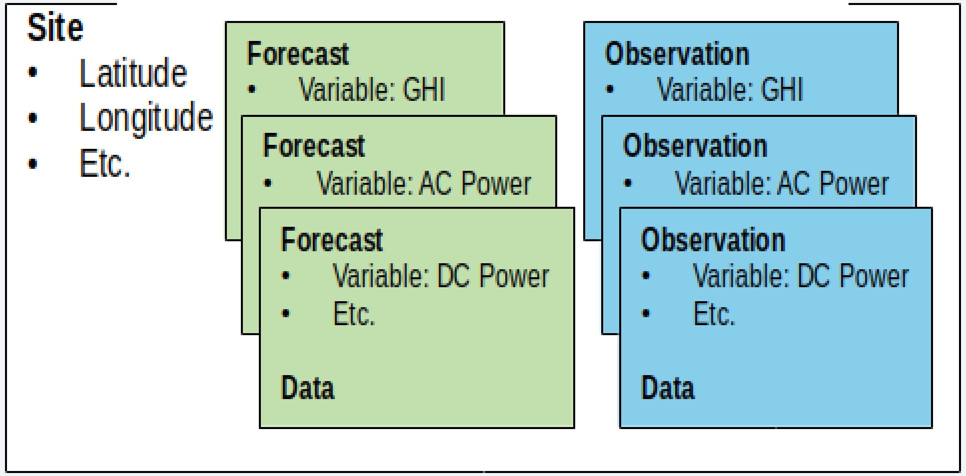
Code	Title	Description
A01	ED50	ED 50 (European Datum 1950) is a geodetic datum which was defined after World War II for the international connection of geodetic networks.
A02	OSGB36	Ordinance Survey Great Britain 1936. The Ordinance Survey (OS) devised the national grid reference system, and it is heavily used in their survey data, and in maps (whether published by the Ordinance Survey or commercial map producers) based on those surveys.
A03	WGS84	The World Geodetic System version 1984. for use in cartography, geodesy, and navigation including by GPS. It comprises a standard coordinate system for the earth, a standard spheroidal reference surface (the datum or reference ellipsoid) for raw altitude data, and a gravitational equipotential surface (the geoid) that defines the nominal sea level.
A04	GTRF	Galileo Terrestrial Reference Frame

Wind Power Forecasting Data Definitions and Exchange Standards – *Data Definition and Exchange Example*

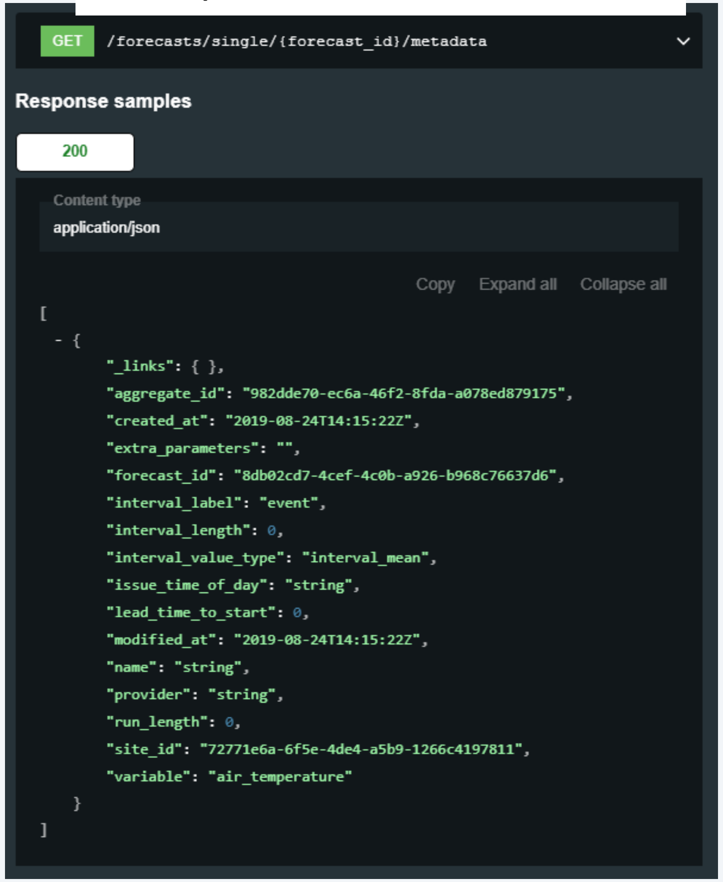
Example 2: US Dept. of Energy Solar Forecast Improvement Project – Solar Forecast Arbiter

- RESTful API using JSON data structures
- Simple PUT, GET, and DELETE http requests
- Can create/delete sites
- Easy to define or update metadata, observations, and forecasts
- Open Source and available through github
- Conducting benchmarks this year

Solar Forecast Arbiter Data Model



Example Metadata Structure

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  - {
      "_links": { },
      "aggregate_id": "982dde70-ec6a-46f2-8fda-a078ed879175",
      "created_at": "2019-08-24T14:15:22Z",
      "extra_parameters": "",
      "forecast_id": "8db02cd7-4cef-4c0b-a926-b968c76637d6",
      "interval_label": "event",
      "interval_length": 0,
      "interval_value_type": "interval_mean",
      "issue_time_of_day": "string",
      "lead_time_to_start": 0,
      "modified_at": "2019-08-24T14:15:22Z",
      "name": "string",
      "provider": "string",
      "run_length": 0,
      "site_id": "72771e6a-6f5e-4de4-a5b9-1266c4197811",
      "variable": "air_temperature"
    }
]
```


**Source: https://solarforecastarbiter.org/*

Wind Power Forecasting Data Definitions and Exchange Standards – *Current Thinking and Approach*

Two levels of standardization

Level 1: High Level / Std terms

- ✓ Data definitions: unambiguous documentation
- ✓ Data type definitions enumerated (e.g., metadata, dynamic data)
- ✓ Data Exchange: multiple options (API, FTP)

1. Forecast System Specifications			
Data field	**Description**	**Value**	**Example**
Power unit	Which power unit do you want for the forecasted values?		W,...
Time zone	What should be the time zone of the forecasted values?		EST,...
Forecast update frequency	How frequent do		in delivery every 4 hours)
Forecast granularit			60 min (one prediction every hour)
Forecast horizon	What is the maximum horizon you want us to forecast? In hours.		168 hours (predictions up to 168 hours ahead)

EXAMPLE – Level 1 Data Standard

Level 2: Repeatable / Scalable

- ✓ Data definitions: unambiguous documentation
- ✓ Data type definitions enumerated (e.g., metadata, dynamic data)
- ✓ IEC 63235/CIM standard compatible; uses UML/XML abstract layer
- ✓ Data Exchange: multiple options (API, FTP)


```
-<xs:complexType name="EnergyPrognosis_MarketDocument" sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-cim16#MarketDocument">
 -<xs:sequence>
   <xs:element minOccurs="1" maxOccurs="1" name="mRID" type="ID_String" sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-cim16#IdentifiedObject.mRID"> </xs:element>
   <xs:element minOccurs="1" maxOccurs="1" name="revisionNumber" type="
   sawsdl:modelReference="http://iec.ch/TC57/2013/CIM
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   /TC57/2013/CIM
   <xs:elem                                           type="PartyID_String"
   sawsdl:m                         cim16#IdentifiedObject.mRID"> </xs:element>
   <xs:eleme                        name="sender_MarketParticipant.marketRole.type" type="MarketRoleKind_String"
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   sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-cim16#IdentifiedObject.mRID"> </xs:element>
   <xs:element minOccurs="1" maxOccurs="1" name="receiver_MarketParticipant.marketRole.type" type="MarketRoleKind_String"
   sawsdl:modelReference="http://iec.ch/TC57/2013/CIM-schema-cim16#MarketRole.type"> </xs:element>
```


EXAMPLE – Level 2 CIM Energy Prog XSD

Two-level approach captures most renewable energy forecast consumers and establishes or borrows from common industry data model (object and classes)

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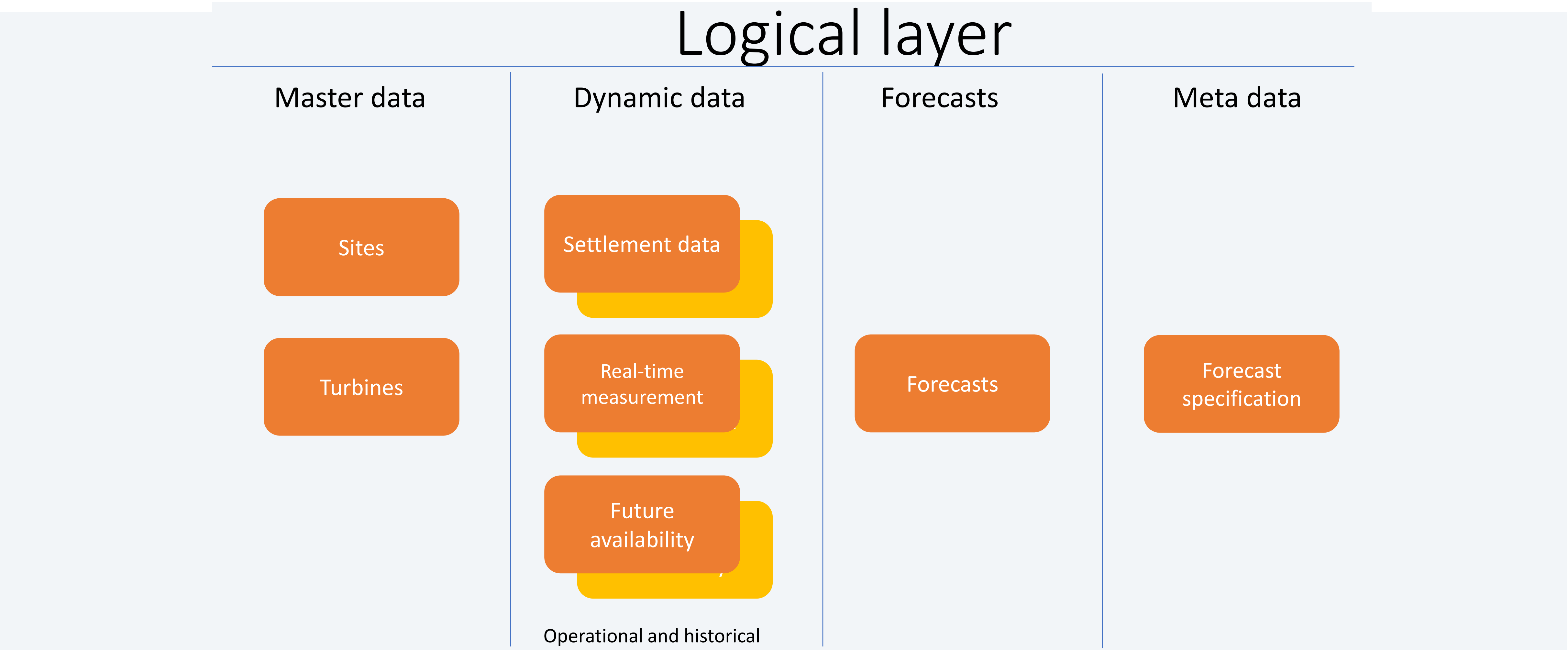
Wind Power Forecasting Data Definitions and Exchange Standards – *Current Thinking and Approach*



There has to be a clear delineation between different data layers since similar data parameter will appear in multiple layers (e.g., weather measurement and forecast)

Wind Power Forecasting Data Definitions and Exchange Standards – *Ongoing Effort*

- ✓ Forecast providers and forecast users (utilities, market participants) are invited to contribute knowledge, use cases, recommendations
- ✓ Core working group as well as reviewers and followers
- ✓ Structured process for developing, reviewing and releasing new best practice version
- ✓ Further review of existing and related standards
- ✓ IEA Task 36 review process
- ✓ Coordinate with other relevant groups and initiatives (e.g., IEC 63043, SFIP2, ETSI, ESIG)

Success will be measured by the adoption of recommended practices by Forecast Providers which will trickle to Consumers

Wind Power Forecasting Data Definitions and Exchange Standards – *Our Target*

- *<u>Widespread adoption</u>* through "buy-in" by forecast providers and large, multinational forecast users
- *<u>Documentation of data definitions</u>* with unambiguous terminology and definitions
- *<u>Open source</u>* and standard way of exchanging data that is both adaptable and abstracted from specific energy market rules and constraints
- Date definitions and data model *<u>immune to evolving IT security constraints and types of generators</u>*
- Publicly available best practices – *<u>free and easily discoverable</u>*

- All parties more satisfied with outcomes
  - Roundtrip forecast delivery : reduced from *<u>weeks to hours</u>*
  - Forecast Providers freed up to focus more on:
    - ✓ Modelling and accuracy *<u>improvements</u>*
    - ✓ More complex and atypical *<u>business requirements</u>*
- Forecast Consumers can easily test and determine value of forecast product

Ultimately, improved forecast quality and lower costs can be achieved through <u>adoption</u> of recommended practices and standards

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