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Business Models and Reference Architecture for IIoT

Reference Architecture – Part 1

Dr. Sudip Misra

Professor

Department of Computer Science and Engineering

Indian Institute of Technology Kharagpur

Email: smisra@sit.iitkgp.ernet.in

Website: http://cse.iitkgp.ac.in/~smisra/

Research Lab: cse.iitkgp.ac.in/~smisra/swan/

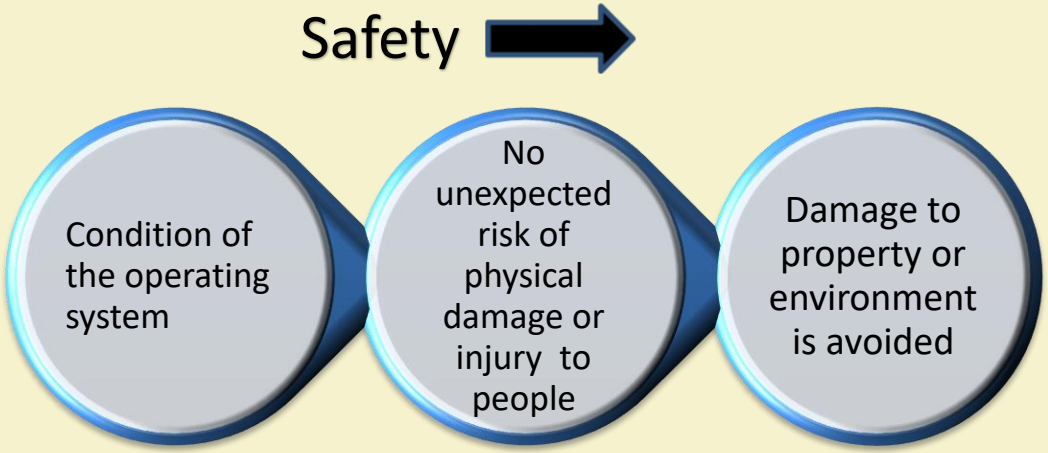
IIRA - Introduction

- Industrial Internet Reference Architecture (IIRA) is an standard architecture for IIoT systems.
- Standards-based architecture proposed by the IIC Technology Working Group
- Current Version: IIRA v1.8
- IIRA is broadly applicable in the industrial systems to
  - allow interoperability
  - map application technologies
  - guide technologies

Source: “IIoT Reference Architecture”, IIoT World

IIRA - Introduction (contd.)

- Safety is the major concern in the IIRA infrastructure, and is to be followed by security.



Source: "IIoT Reference Architecture", IIoT World

Key Performance Indicators (KPIs) for Occupational Safety and Health (OSH):

- Key performance indicators for OSH is
  - a measure of the activities of an organization
  - connect/communicate with customer
  - provide valuable feedback
  - drive towards improvement

Source: “Performance Indicators”, Oshkiwi
“KPIs”, Beyondlean

Key Performance Indicators (KPIs) for Occupational Safety and Health (OSH) (contd.)

- Based on the leading and lagging OSH indicators, KPIs are also categorized into
  - **Leading KPI** is mainly used to predict the economy. It is
    - input-oriented, and
    - hard to measure.
  - **Lagging KPI** is a technical indicator which changes after the economy has begun. It is
    - output-oriented, and
    - hard to improve

Source: "Performance Indicators", Oshkiwi
"Lagging and Leading Indicators", Kplibrary

Key Performance Indicators (KPIs) for Occupational Safety and Health (OSH) (contd.)

- Number of lost-time incident frequency rate
- Production days lost due to sickness absence
- Incidents or near misses
- Number of fatalities

Lagging KPIs

- Percentage of managers with adequate OSH training
- Percentage of workers with adequate OSH training
- Frequency of observed unsafe behaviour
- Number of OSH audits

Leading KPIs

Source: "Performance Indicators", Oshkiwi

Industrial Internet Consortium (IIC)

- Industrial Internet Consortium (IIC) is a non-profit organization created for
  - promotion of open standards
  - interoperability for technologies

  used in industries and machine-to-machine (M2M) environments.
- Testbeds are an area of major focus and activity of the IIC members.

Source: "Test Beds", IIConsortium

Industrial Internet Consortium (IIC) (contd.)

- In IIC, the innovations and opportunities of the new technologies, new applications, new processes, new products and new services are
  - initiated,
  - conceptualized, and
  - rigorously tested

  before they are launched in the market.

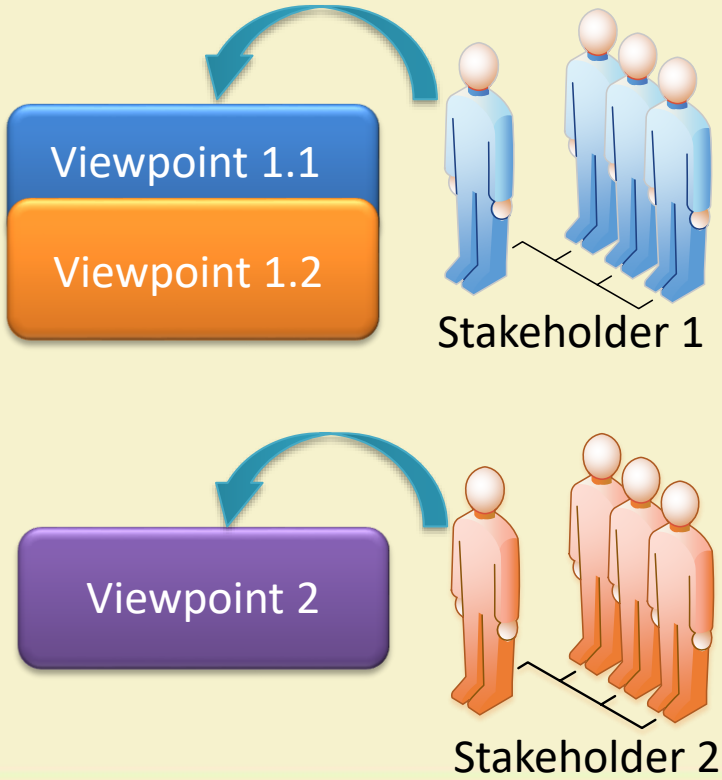
Source: "Test Beds", IIConsortium

IIRA Framework

- Stakeholders are the
  - individual, team or organizations having interest concerning to a system
  - interest in the viewpoint and system.
- Viewpoints are the collection of ideas which
  - describe,
  - analyze, and
  - solve the set of specific concerns.

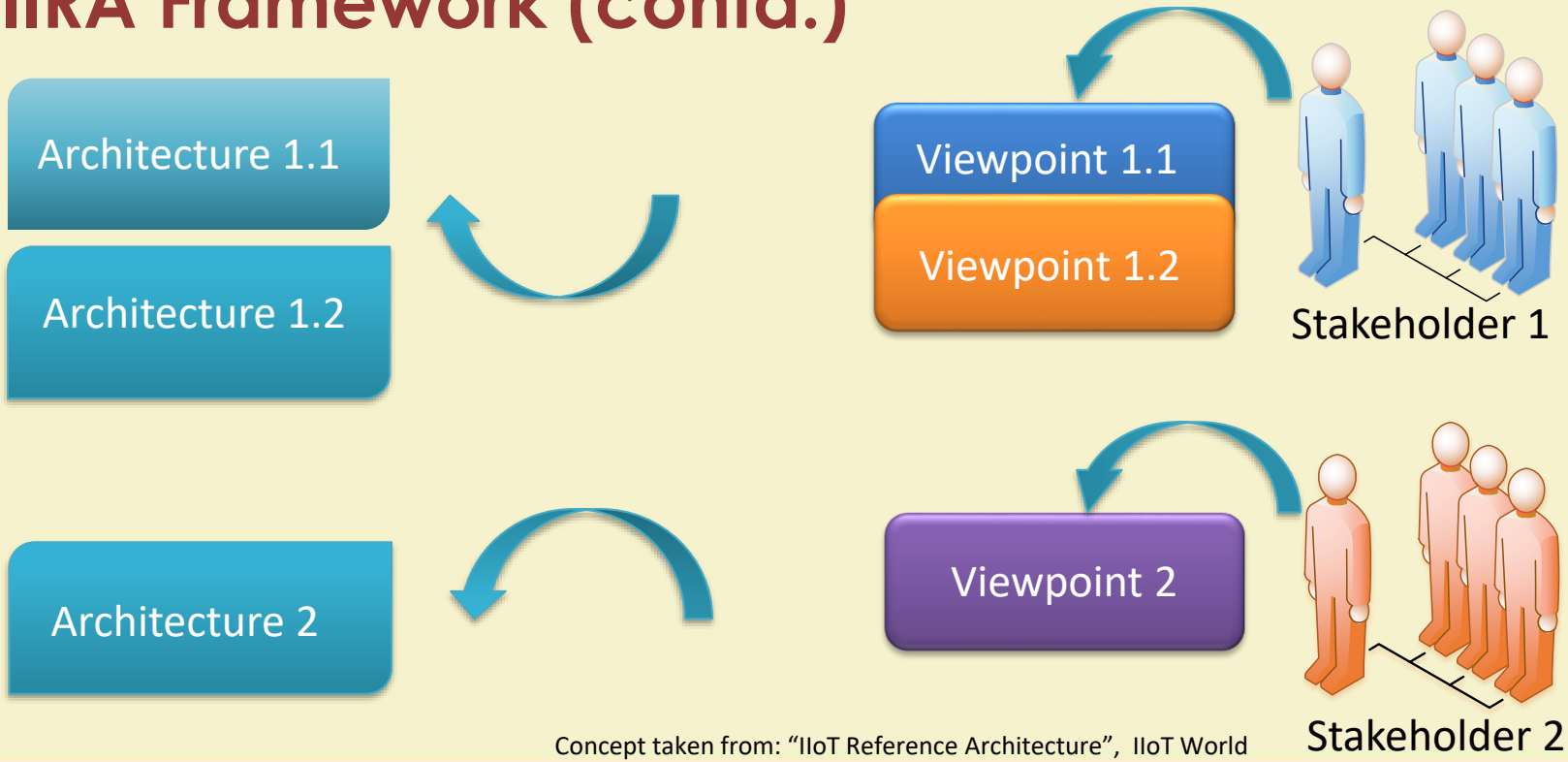
Source: "IIoT Reference Architecture", IIoT World

IIRA Framework (contd.)



Concept taken from: "IIoT Reference Architecture", IIoT World

IIRA Framework (contd.)



Concept taken from: "IIoT Reference Architecture", IIoT World

IIRA Framework (contd.)

- Architecture frame is the collection of ways which
  - identify,
  - describe, and
  - analyze the ideas of stakeholders

- Architecture representation is the collection of outcomes of
  - architecture frame, and
  - expressed as a view.

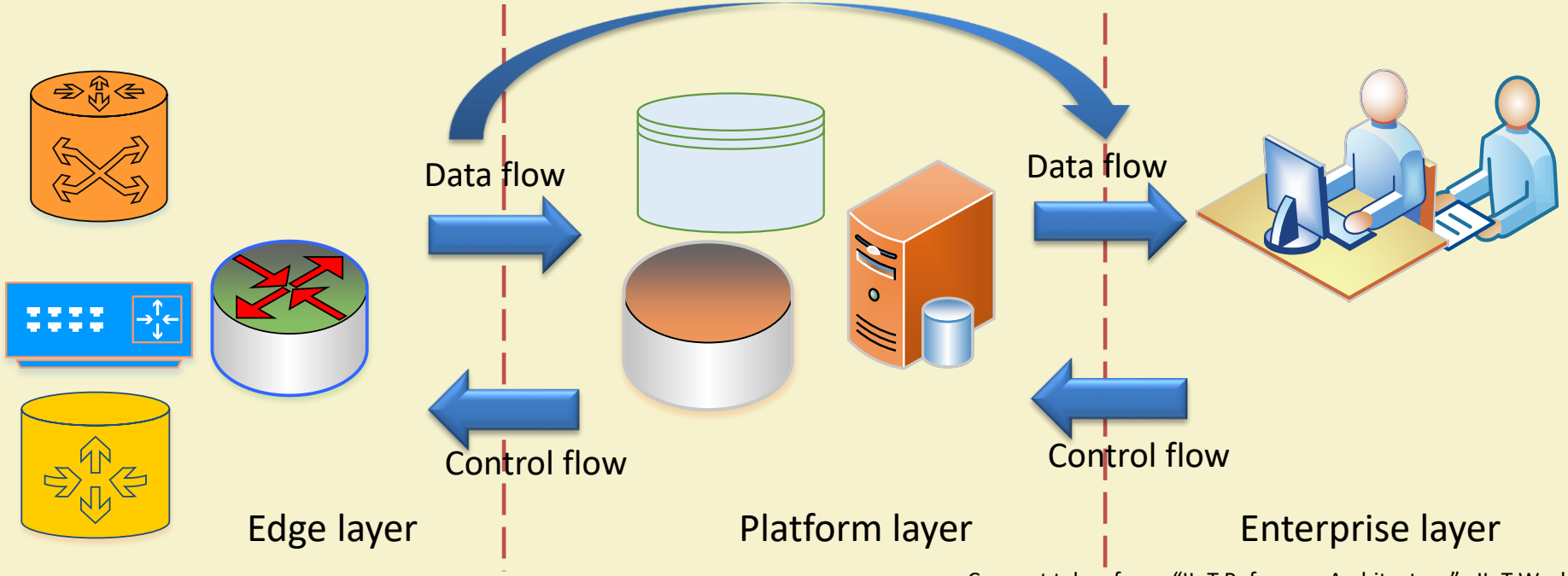
Source: "IIoT Reference Architecture", IIoT World

IIRA-Architecture Patterns

- Different **IIoT architecture implementation patterns** are as follows:
  - Three-tier architecture pattern
  - Gateway-mediated edge connectivity and management architecture pattern
  - Layered databus pattern

Source: "IIoT Reference Architecture", IIoT World

IIRA: Three-tier architecture pattern



Concept taken from: "IIoT Reference Architecture", IIoT World

IIRA: Three-tier architecture pattern (contd.)

- **Edge layer** gathers data from the edge nodes. The architecture includes
  - breadth of distribution
  - governance
  - location
- **Platform layer** receives, process, and forwards control commands from the enterprise layer to the edge layer.

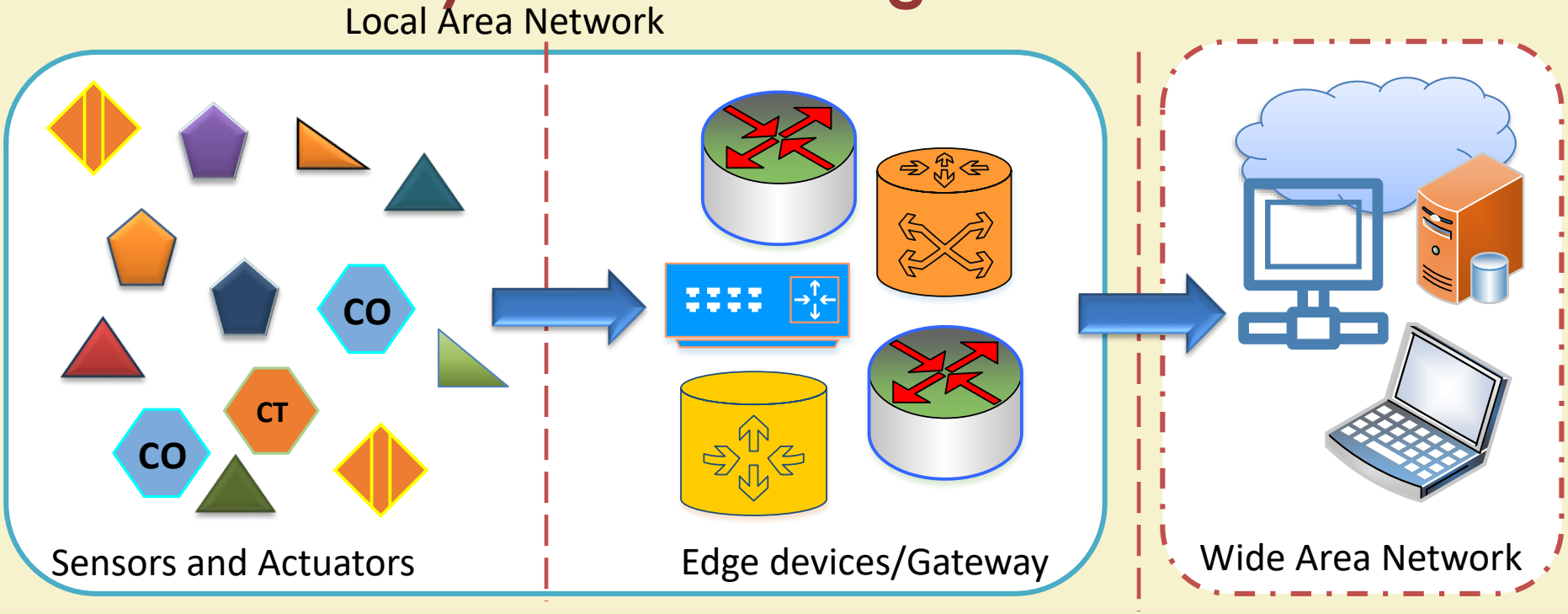
Source: "IIoT Reference Architecture", IIoT World

IIRA: Three-tier architecture pattern (contd.)

- **Enterprise layer** receives data flows from edge layer and platform layer. The Enterprise layer implements
  - domain-specific applications,
  - decision support systems, and
  - provides interfaces to end-users.

Source: "IIoT Reference Architecture", IIoT World

IIRA: Gateway-Mediated Edge Architecture



Concept taken from: "IIoT Reference Architecture", IIoT World

IIRA: Gateway-Mediated Edge Architecture (contd.)

- The **gateway-mediated edge architecture** consists of
  - a local area network for the IIoT edge system, and
  - the gateway connecting the Wide Area Network.

- The local area network may use
  - hub-and-spoke topology
  - mesh topology

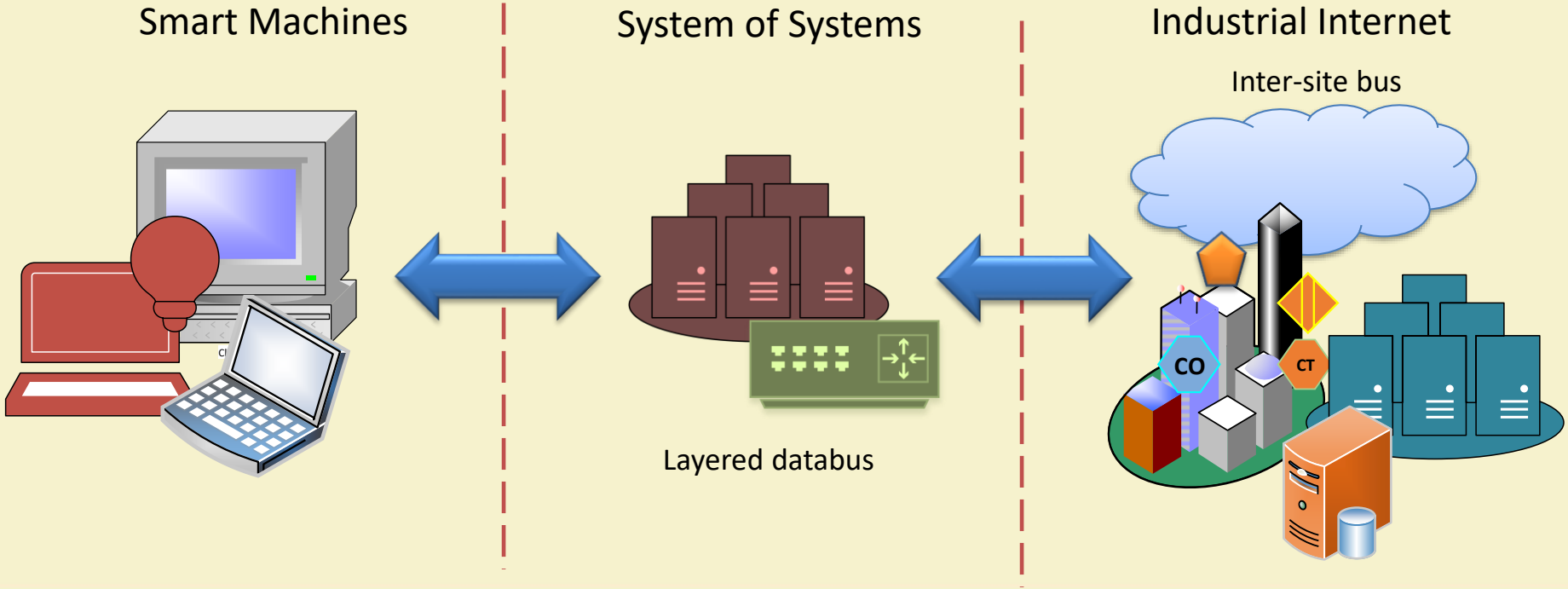
Source: "IIoT Reference Architecture", IIoT World

IIRA: Gateway-Mediated Edge Architecture (contd.)

- The gateway devices act as
  - management point for the edge devices locally
  - data transfer, processing and analytics
  - local connectivity among the devices
  - application logic which performs within the local scope.

Source: "IIoT Reference Architecture", IIoT World

IIRA: Layered Databus Pattern



Concept taken from: "IIoT Reference Architecture", IIoT World

IIRA: Layered Databus Pattern (contd.)

- Smart machines are present in the lowest level for
  - local control,
  - automation.
- System of systems allows
  - complex systems,
  - monitoring, and
  - analytic applications

Source: "IIoT Reference Architecture", IIoT World

IIRA: Layered Databus Pattern (contd.)

- Layered Databus pattern is applicable in the field of
  - control,
  - local monitoring, and
  - analytics.
- The databus communicates between applications and devices.
  - It allows interoperable communication between endpoints.
  - For communication between machines, another databus is used.

Source: "IIoT Reference Architecture", IIoT World

IIRA: Layered Databus Pattern (contd.)

- Layered Databus pattern allows
  - fast device-to-device integration with minimum response time.
  - automatic data and application delivery
  - scalable integration of devices
  - availability of the system is high, and
  - hierarchical subsystem isolation.

Source: "IIoT Reference Architecture", IIoT World

References

[1] Anthea Zacharatos and Julian Barling, Roderick D. Iverson, “High-Performance Work Systems and Occupational Safety”, Journal of Applied Psychology, 2005, Vol. 90, No. 1, 77–93.

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[4] P A Wordworth, “A Reference Architecture for Enterprise Architecture”.

[5] William Ulrich, “Business Architecture: The Art and Practice of Business Transformation”.

[6] Graham Meaden and Jonathan Whelan, “Business Architecture: A Practical Guide”.

Thank You!!