

Interfacing NIST IoT, Big Data, and Cloud Models

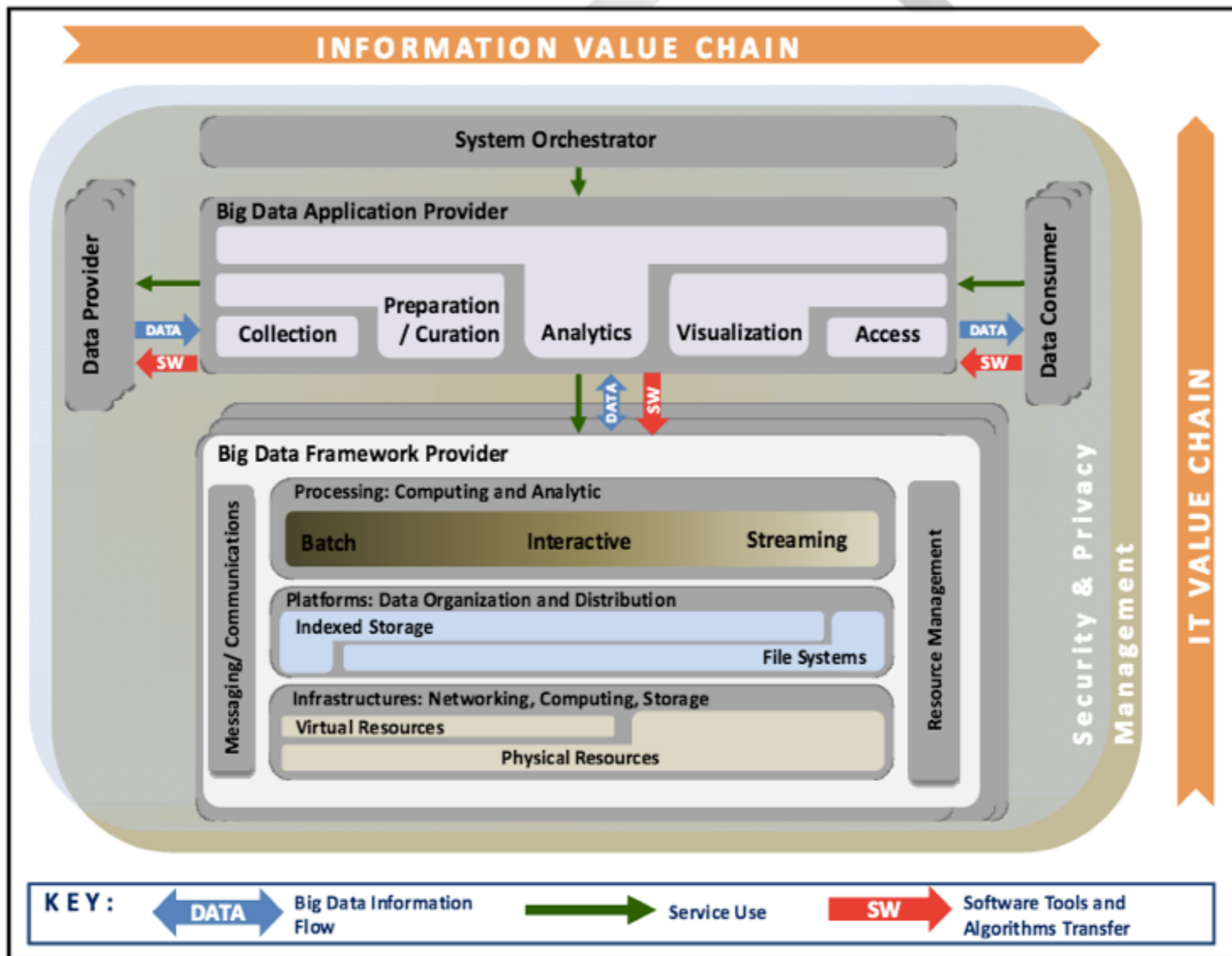
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Reference: Current NIST IoT, Big Data, and Cloud Models

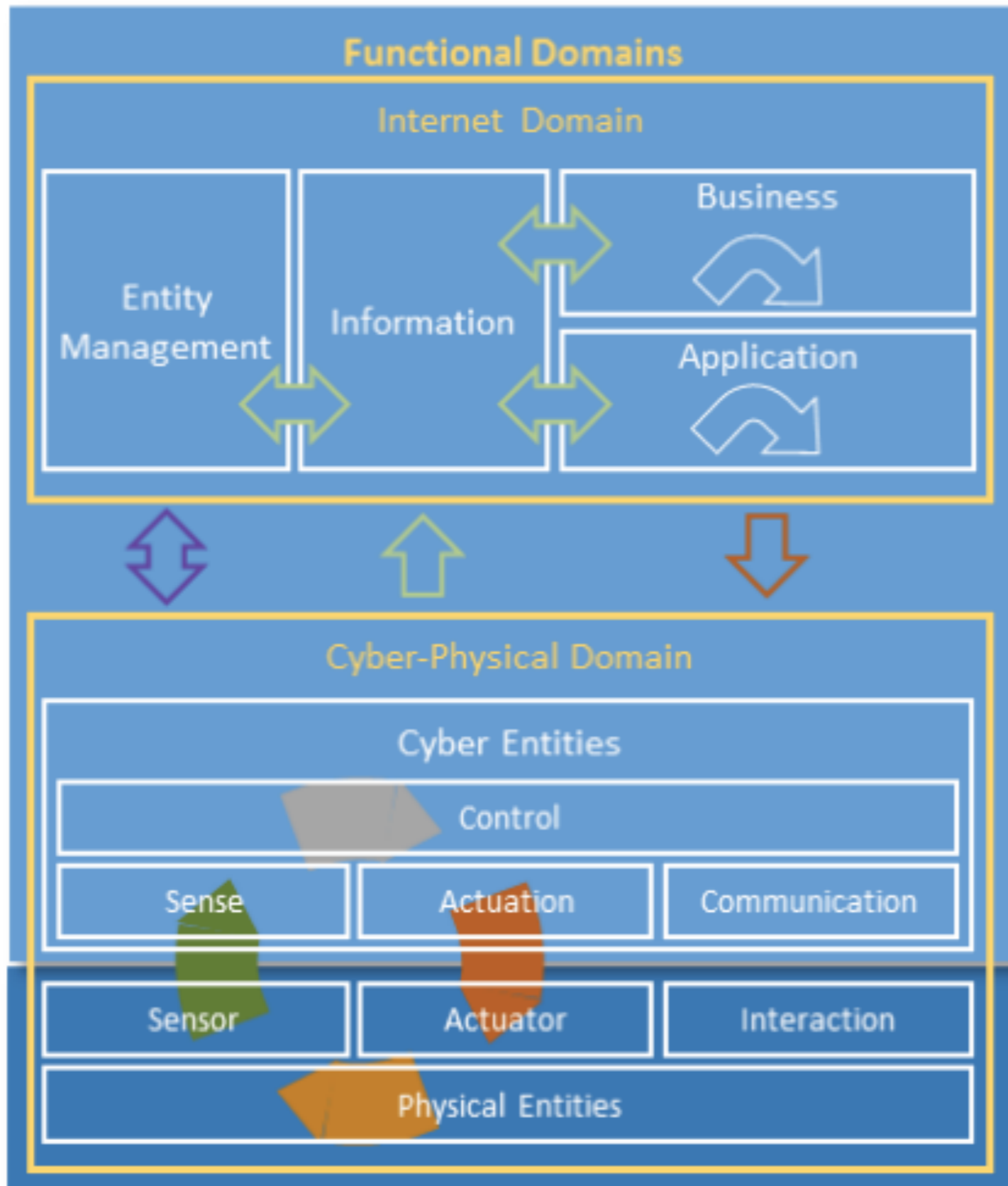
NIST Big Data Reference Architecture

http://bigdatawg.nist.gov/uploadfiles/M0397_v1_2395481670.pdf



NIST Framework for CPS Systems

<http://www.cpspwg.org/Portals/3/docs/CPS%20PWG%20Draft%20Framework%20for%20Cyber-Physical%20Systems%20Release%200.8%20September%202015.pdf>



Green Arrows: Information Flow
Grey Arrows: Decision Flow
Red Arrows: Action Flow
Orange Arrows: Energy/Material Flow
Purple Arrows: Management Flow

NIST Cloud Reference Architecture

http://www.nist.gov/customcf/get_pdf.cfm?pub_id=909505

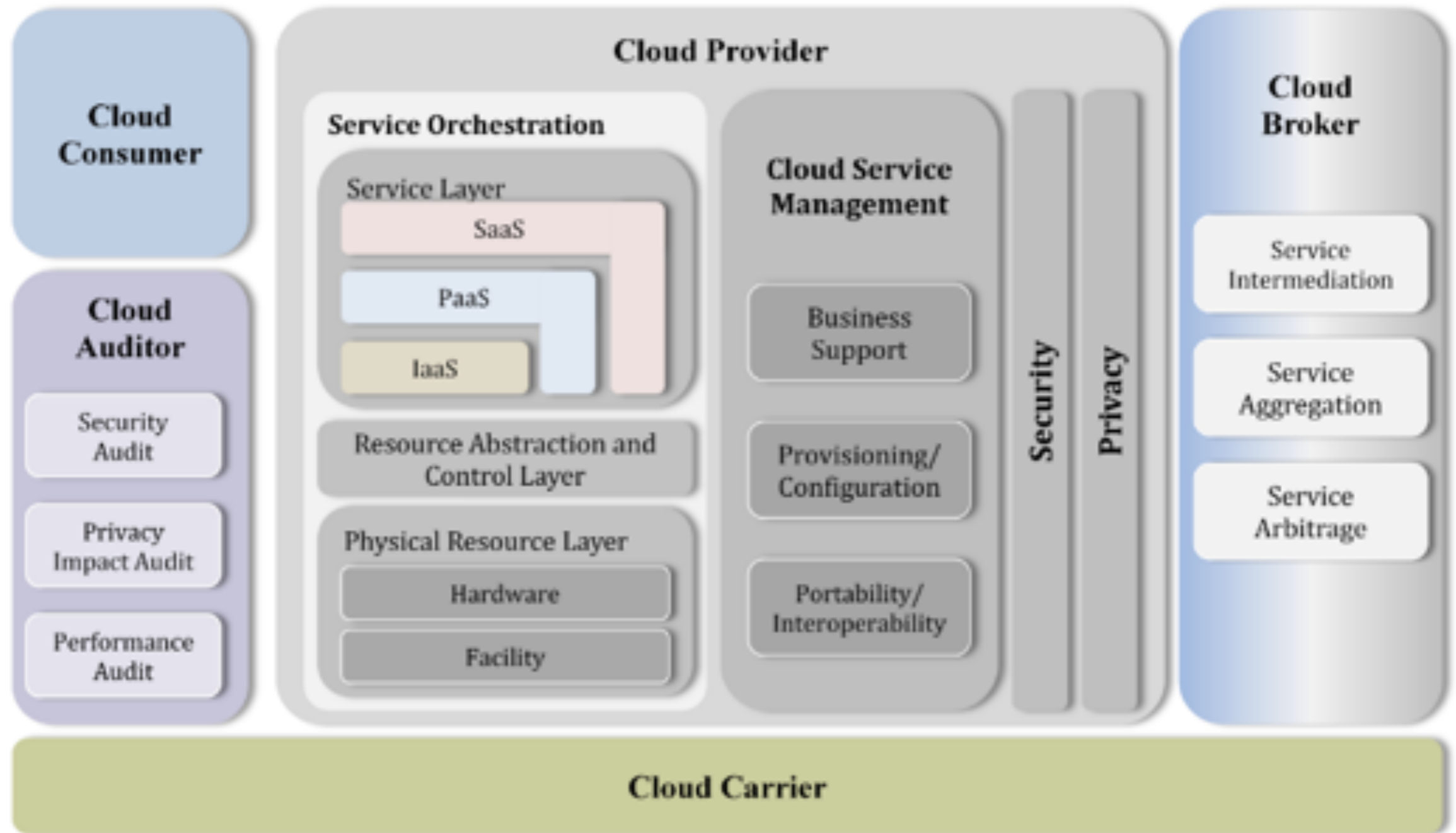
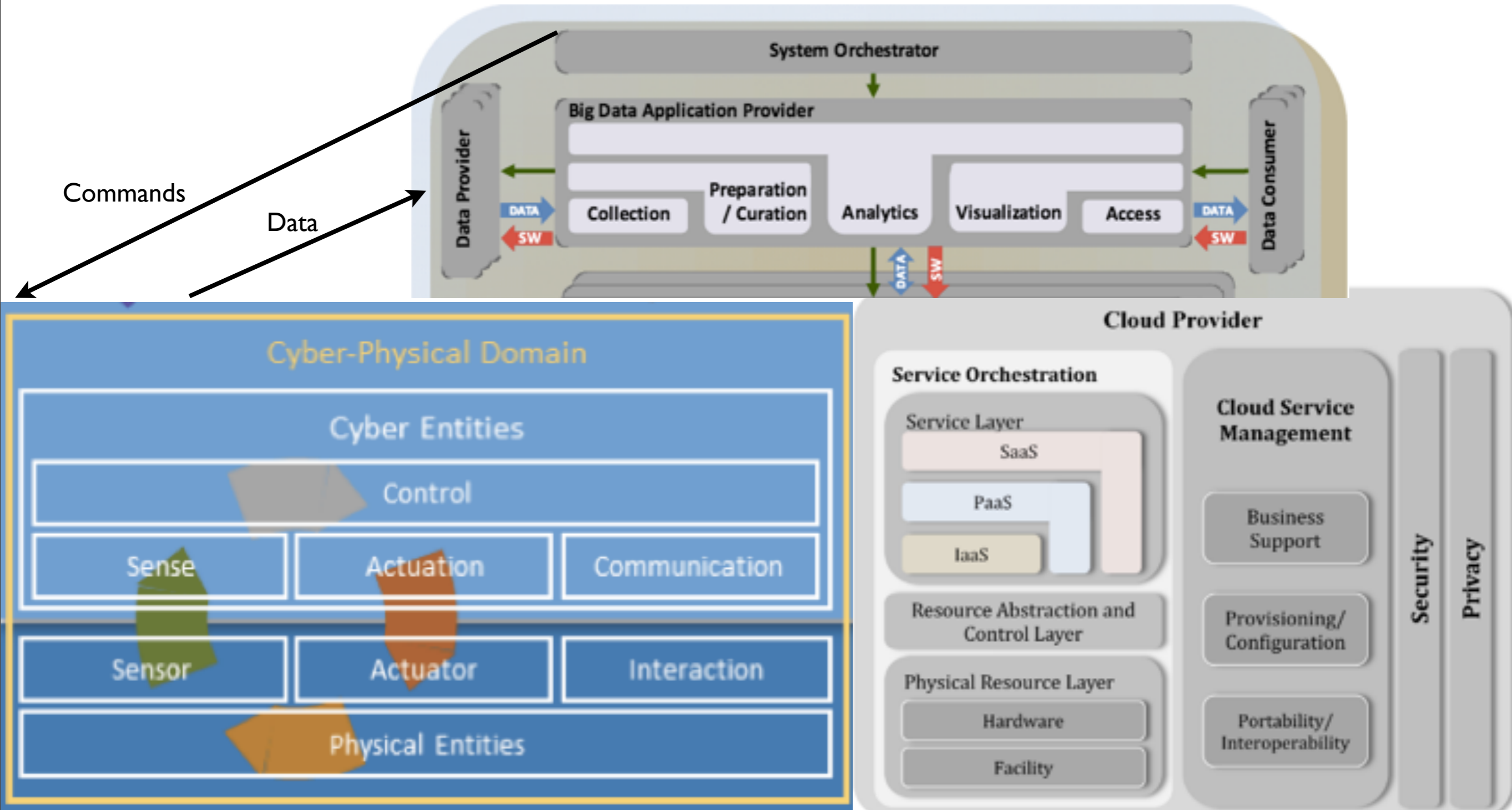


Figure 1: The Conceptual Reference Model

Interfacing NIST IoT, Big Data, and Cloud Models

Interfacing NIST CPS, Big Data, and Cloud Models



Large Horizontally Scaled Cyber-Physical Systems

Example of a Generic Use Case that has many specific applications

- Multiple devices collect and broadcast large amounts of data (e.g. IoT)
- Data is sent to distributed storage and/or processing platforms (e.g. Cloud)
- Distributed analytic processing is performed on uploaded data (e.g. Big Data)
- Based on analysis, decisions can result in commands being sent to devices
- Data processing can be done at different time scales e.g. real-time, interactive, batch

High Level Questions about Interface among Models

- *Note: Interfaces include network protocols, APIs, data formats, middleware, etc.*
- What are the interfaces between Cyber-Physical Systems and Big Data Applications?
- What are the interfaces between Big Data Applications and Cloud?
- Cross Reference Model issues: security, privacy, monitoring, management etc.

Cyber-Physical Systems and Big Data Applications Interfaces

- Cyber-Physical Systems are Data Providers to Big Data Applications
- Analytics can be performed at different time scales (e.g. real-time, interactive, batch)
- Applications can send Commands to Cyber-Physical Systems
 - Big Data System Orchestrator could be the Decision Provider (possible renaming?)
- Cyber-Physical System is a consumer of Commands
- Interfaces between Models can be through a middleware layer
 - Standards and/or middleware brokers are needed for interoperability

Big Data Applications and Cloud Interfaces

- Big Data Applications are Cloud Consumers
- Cloud Model doesn't specify interfaces between Consumers and Provider
- See NIST Cloud document for more detailed descriptions
http://www.nist.gov/customcf/get_pdf.cfm?pub_id=909505
- Big Data Applications can run on top of IaaS, PaaS, or SaaS
 - IaaS - Cloud supplies only computing and data storage resources.
 - PaaS - Cloud supplies database and data processing capabilities
 - SaaS - Cloud supplies generic analytic and decision software and supporting resources
 - Application Provider supplies problem-specific analytic and decision code in all cases + underlying resources that are not supplied by Cloud Provider

Cross Model Issues

- Security and Privacy across Applications and Cloud require collaboration
 - Responsibilities vary depending on SaaS, PaaS, or IaaS deployment
- Security and Privacy across Applications and CPS will probably require middleware
 - See <https://www.usenix.org/system/files/conference/hotcloud15/hotcloud15-zhang.pdf>
- Cross Model Monitoring and Management will also require gateways and/or standards
 - Many new products available <https://blog.profitbricks.com/top-49-tools-internet-of-things/>

Some Suggestions for the Future

- The interface between CPS and Applications will probably be a middleware broker
 - This broker should be modeled explicitly to capture its role and responsibilities
- Processing at different time scales should be mapped to the Big Data Reference Architecture
 - Current model does not differentiate between real-time, interactive, and batch processing
- Big Data System Orchestrator could be renamed Decision Provider to be more understandable
 - This component could send commands to CPS in addition to its current role
- Cloud and Big Data models could be combined for horizontally scaled applications
 - The line between Applications and Cloud would depend on SaaS, PaaS, or IaaS deployment e.g. Figure 18 in http://bigdatawg.nist.gov/_uploadfiles/M0008_v1_7256814129.pdf
 - The interface between Big Data and Cloud models could be a broker, wrapper, or API

Reference: Links to IoT, Big Data and Cloud Interface Pages

Reference Links

Global Data Plane Middle Layer between IoT and Cloud Analytics from Berkeley SwarmLab

<https://swarmlab.eecs.berkeley.edu/projects/4814/global-data-plane>

<https://www.usenix.org/system/files/conference/hotcloud15/hotcloud15-zhang.pdf> (Pitfalls for direct IoT to Cloud interfaces)

Principles for IoT Clouds and IoT Cloud Systems from Distributed Systems Group at TU Wien

<http://www.infosys.tuwien.ac.at/research/viecom/papers/Truong2015Principles.pdf>

<http://www.slideshare.net/linhsolar/principles-for-engineering-elastic-iot-cloud-systems>

Cloud Sensor Architecture from University of Florida

<http://www.icta.ufl.edu/projects/publications/ceb.pdf>

Diagram Showing Interfaces between CPS, Analytics, and Cloud from Microsoft

<http://blogs.technet.com/b/dataplatforminsider/archive/2014/10/29/microsoft-adds-iot-streaming-analytics-data-production-and-workflow-services-to-azure.aspx>

Virdata Platform as a Service for IoT on IBM and AWS

http://www.slideshare.net/nathan_gs/virdata-lessons-learned-from-the-internet-of-things-and-m2-m-cloud-services-at-ibm-big-data-developers-meetup

<http://www.virdata.com/portfolio/amazon-web-services-and-virdata-webinar-entitled-scaling-out-the-internet-of-things/>

Helix Device Cloud from Intel's Wind River

http://download.intel.com/newsroom/kits/iot/insights/2014/pdfs/WR_Edge_Management_System-ProductOverview.pdf

IoT, Big Data, and Cloud Convergence in European-Japanese IKaaS Project

<http://ikaas.com/>

<http://www.slideshare.net/DrIngAbdurRahimBiswa/internet-of-things-iot-is-a-king-big-data-is-a-queen-and-cloud-is-a-palace>

http://ec.europa.eu/information_society/newsroom/cf/dae/document.cfm?action=display&doc_id=7646

Industrial Internet Consortium Reference Architecture

<http://www.iiconsortium.org/IIRA-1-7-ajs.pdf> (free registration required)

Connecting IoT and Cloud - Six Start-ups

<http://www.forbes.com/sites/janakirammsv/2015/04/13/6-iot-startups-that-make-connecting-things-to-the-cloud-a-breeze/>

FTC Report on Security and Privacy for Internet of Things

<https://www.ftc.gov/system/files/documents/reports/federal-trade-commission-staff-report-november-2013-workshop-entitled-internet-things-privacy/150127iotrpt.pdf>