



Digital Cities ITS Urban Mobility Platform

Optimizing Universal Transportation in Digital Cities of the Future with an Event-Driven Mesh Architecture and iPaaS Data Integration Platform

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Introduction to Unified Transportation Data and Message Services

Optimizing your public transport systems, can help citizens get where they're going more quickly by reducing congestion on roadways and intelligently allocating and routing buses to areas with more travelers. Surfacing relevant and real-time data for operational and future planning is at the heart of a good nation or city ITS UM strategy.

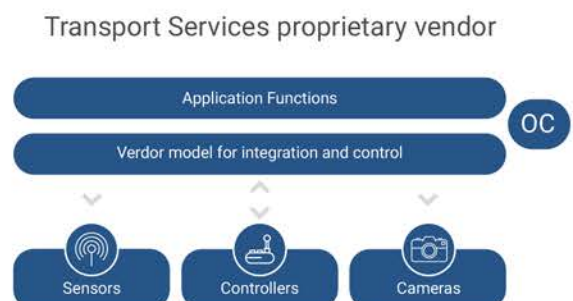
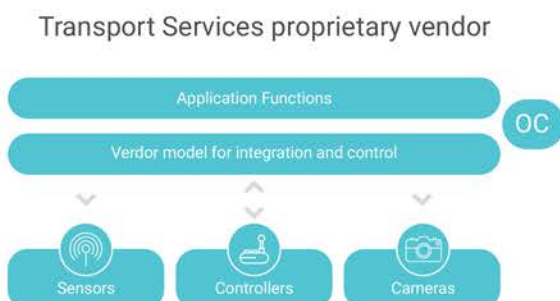
Generations of diverse transportation technologies are currently deployed by cities, agencies and ministries of transport. The standards and propriety protocols employed by most will be unable to communicate with each other. While this has served its silo use case purpose for many years, new pressures create demand for integrated intelligent systems to solve modern city transport problems.

Common challenges that need to be overcome:

- An unclear vision of transport assets and status in real-time
- Well-intentioned city planners unwittingly create silos when trying to implement smart transport systems over the years without a framework
- Connecting in real-time multi-modal transport systems
- Combining multi-model ticketing systems
- Bridging the gap, the of silo legacy and multi-vendor transport systems
- Getting a diversity of transport information into valued insight
- High Complexity/Cost of combining transport ERP systems
- Unable to deliver truly integrated real-time services

Traditional Silo Model Siloed Services Model

Services in Silo's:



Cities will have a natural diversity of road, rail and air management ICT systems acquired over many years. The opportunity to bring sources of data together as

one can provide transformational operations and active smart decisions based on real data is now possible in a cost-effective and scalable manner.

Dell Technologies have invested in combining the best modern practices to address the needs of modern ITS and Urban Mobility Planning

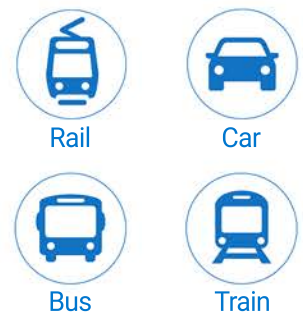
The complexity and solutions for transportation available in the global market will continue to see natural competitive technology

- Turning transport information into insight
- Integration of multi-platform ERP systems
- Cross-platform ticketing integration service layer
- Surfacing and sharing of critical transportation information
- Full integration to cloud services, AWS, SFDC, Azure
- Supporting blockchain onboarding

Our Digital Cities vision has been to work on solutions to solve low levels of integration and realism of legacy systems simply cannot be replaced. However, our recommendation of standards is foremost in new acquisitions of transport technology, so our systems proposed are supporting next-generation standards as shall be outlined.

Integrated Service Model

Surfacing Actionable Data -- Lower Cost -- Multi-agency sharing



Common Shared Services Layer for IOT and interconnected devices

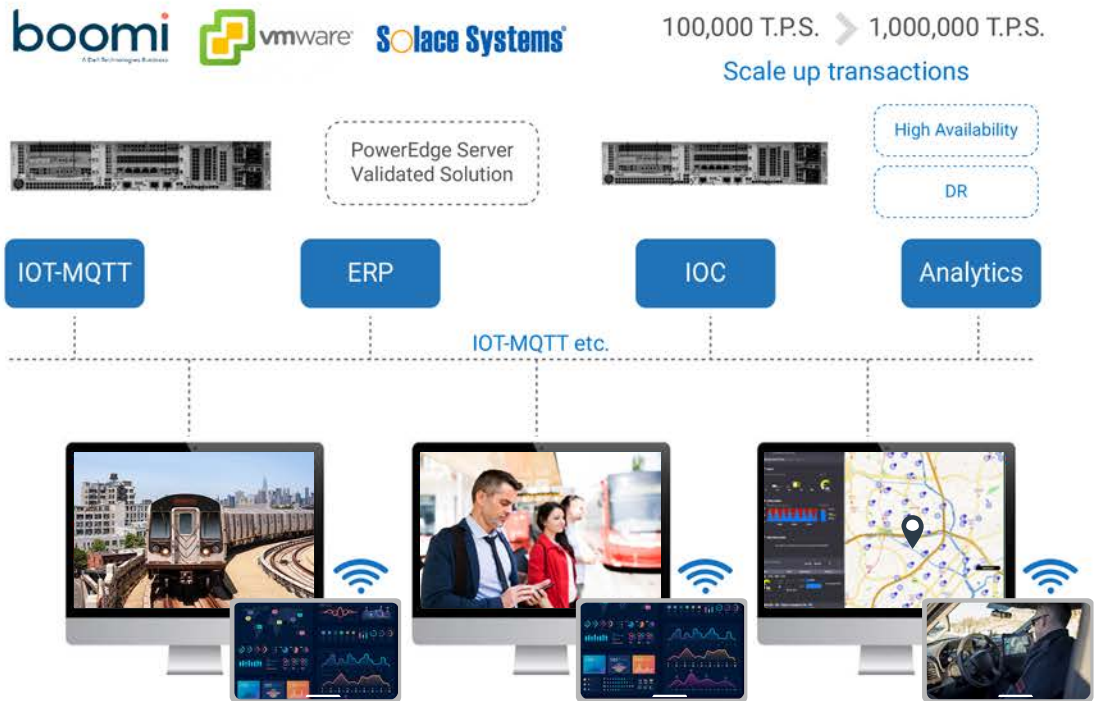


DiCi Integrated Transport Data Backbone and Message Router (DBMR)

Together, the world leader in iPaaS Dell Boomi and Solace leading event processing platform provide integration and data movement for any hybrid

environment at scale, regardless of complexity — meeting the demands of the modern enterprise transportation and government.

Architecture Model of Dell ITS DBMR



Technical Processing Pipeline

Collecting data as real-time/batch, routing, provision of identity and security are paramount in the design process. No critical defined data shall be lost, data integrity is key, reception of data must have guarantees of service acknowledgment at millisecond tolerances in some cases. Data must also be transported, transformed and repackaged from diverse systems. The data shall be received utilizing Restful API or Subscription, these are design decisions for the system integrator or end-user teams using their respective IOC or OC systems.

DBMR Processing functions



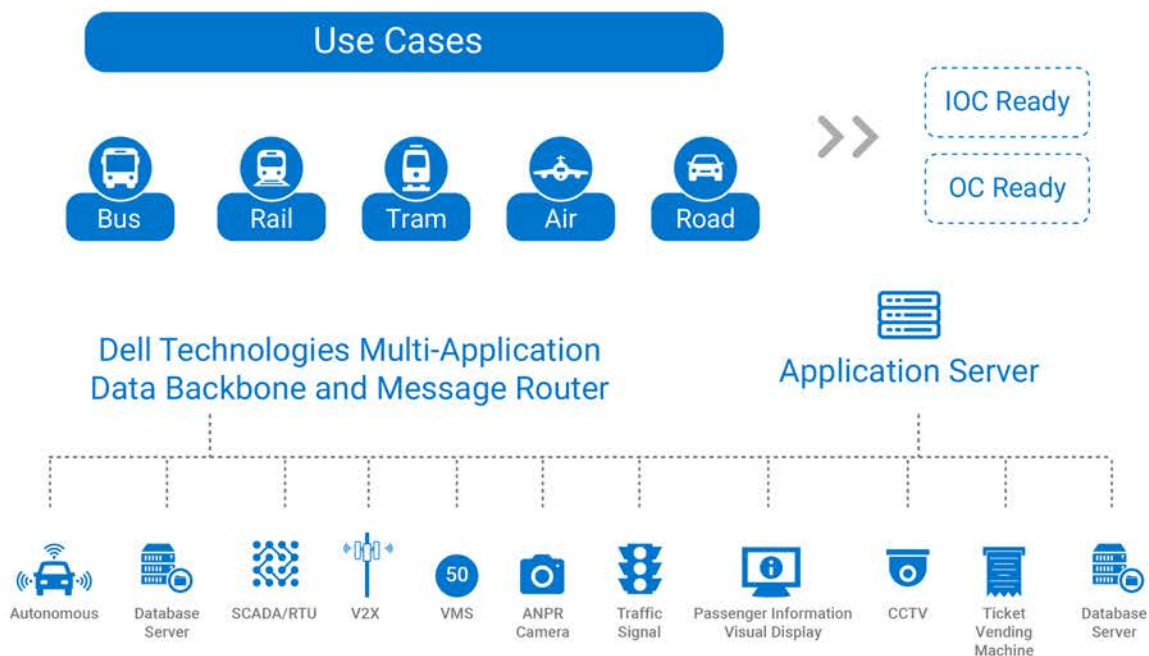
Sensing, reactive, adaptive, predictive, secure and autonomous backbone EDI service compliant



The data pipelines can be built at high speed using Dell BoomiFlow on the AtomSphere Web Platform. This eliminates the complex development of connectors and manual programming of pipelines.

Each SI or End User should survey current systems, in-flight and future systems based on the clear vision set out for the ITS UM city program. Once design and implementation are achieved a richly diverse set of information can be accessible, routed and processed in various operational or decision-making systems.

Connecting Diversity Transportation Systems



The surfacing of data and events in the ITS UM

The ITS UM platform provides the vast possibility of data processing, event handling and store/forward means of processing.

Data can be processed in the following ways

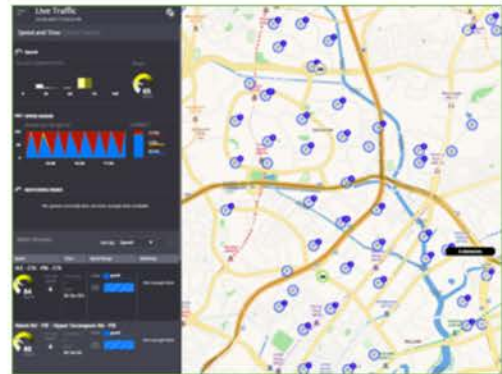
- > **Passed thru complex event processing** - trigger on events alert processing subsystems, this may include operational SMS, mobile application alerts and public information systems
- > **Data is passed into operational databases applications** - systems which access SQL/NoSQL for alerting or decision-making common methods of Restful API's are often employed
- > **Data passed into data lakes** - Connectors and flows connect to Hadoop HDFS. Data used for AI and deeper analytics. Such data will often be used by a transport data scientist or preconstructed applications for delivering planners critical decision information
- > **Data events captured by message subscriber applications** - Applications which are using message queues and listeners
- > **Data or events sent to common Cloud SaaS services** - SaaS applications installed within internal or contractor eco-systems. Examples include service-now, taleo and including e-payment gateways.

Example of Realtime collection from active bus network

Data is collected in real-time and processed in one or more of methods outlined in data processing methods.



The surfacing of ITS UM data is often routed and actioned in IOC's. Integrated Operations Centers.



Sample dashboard of event data provided by Dell DAP IOC Platform enabled from a DBMR platform.



Dell Technologies can provide additional information for SI's and End-User Customers.

System Platform Components

Large core broker system

Dell PowerEdge 730XD

Packaged hypervisor options base support.

Native Hypervisor	Version
VMware vSphere Hypervisor (ESXi)	6.0, 6.5
VMware vSphere Hypervisor (ESXi) when using SSD drives for the PubSub+ or the external block device	6.0, 6.5+

Many organizations will have their own VMWARE licensing which can be used. ESXi standard should be the absolute baseline, this shall require vCentre

Dell ITS DBMR System shall be capable of supporting additional applications as part of the transportation system architecture where the broker as maximum Pub-Sub performance.



Edge broker system

- Dell Precision 3930 (Dell ITS DBMR verified)
- Intel Core i7-9700,
- Windows 10 Pro 64bit English, 32GB 4x8GB DDR4 2666MHz UDIMM Non-ECC Memory.

The Pub-Sub systems shall run on Native Windows 10. Configuration of failover is configured within the PubSub console at the application level as VMWARE ESX is not used on Edge. The use of Docker Containers is supported.



Connections and tiering baseline

A transport eco-system may have a very small number of connections to millions of potential connections. A review is performed on the current situation and forward-looking estimations of digital assets

Connection Scaling Tier	Processors (vCPU)*	RAM (GB)	Disk (GB)
upto 100 connections	2 (1 for a monitoring node)	1	30
upto 1,000 connections	2	4	30
upto 10,000 connections	minimum of 4	12	30
upto 100,000 connections	minimum of 8	28	30
upto 200,000 connections	minimum of 12	56	30

Software Components:

During the assessment stage software inventory shall be further defined. However, the DBMR will in most cases is expected to use the following software components.

Hypervisors or host OS:

- VMWARE ESX 6.5 (Core system only)
- Windows 10 Edge installations (Configured for Site to Site controlled or uncontrolled failover) *For POC development an Edge Window 10 Broker system can support functional testing.*

Publishing and Subscription Software from Solace:

Solace offers the following types of software event brokers:

- PubSub+ Event Broker: Standard: Free, full-featured, and production deployable.
- PubSub+ Event Broker: Enterprise: High-performance, full scale, and enterprise-ready; available through a paid operating license.

Planners may work with the Dell team on the overall planning of iPaaS and Solace configurations at the requirements gathering and review phase. Projects may

begin with standard free deployment with Low connections count and then scale as the system expands. The schema and topics shall remain unchanged.

To assist in understanding differences of versions and how best to configure.

Features	PubSub+Event Broker: Standard	PubSub+Event Broker: Enterprise
High-availability (HA)	Yes	Yes
Data Center Replication (DR)	Yes	Yes
Dynamic Message Routing (DMR)	Yes	Yes
Message Replay	Yes	Yes
Microgateways	Yes	Yes
Upgradable	Yes	Yes
Number of Message VPNs	1	5
Direct and Guaranteed Performance Combined	10,000 message/sec ingress rate limit	Unthrottled
Scale	upto 1,000 client connections	upto 200,000 client connections

Boomi Configuration

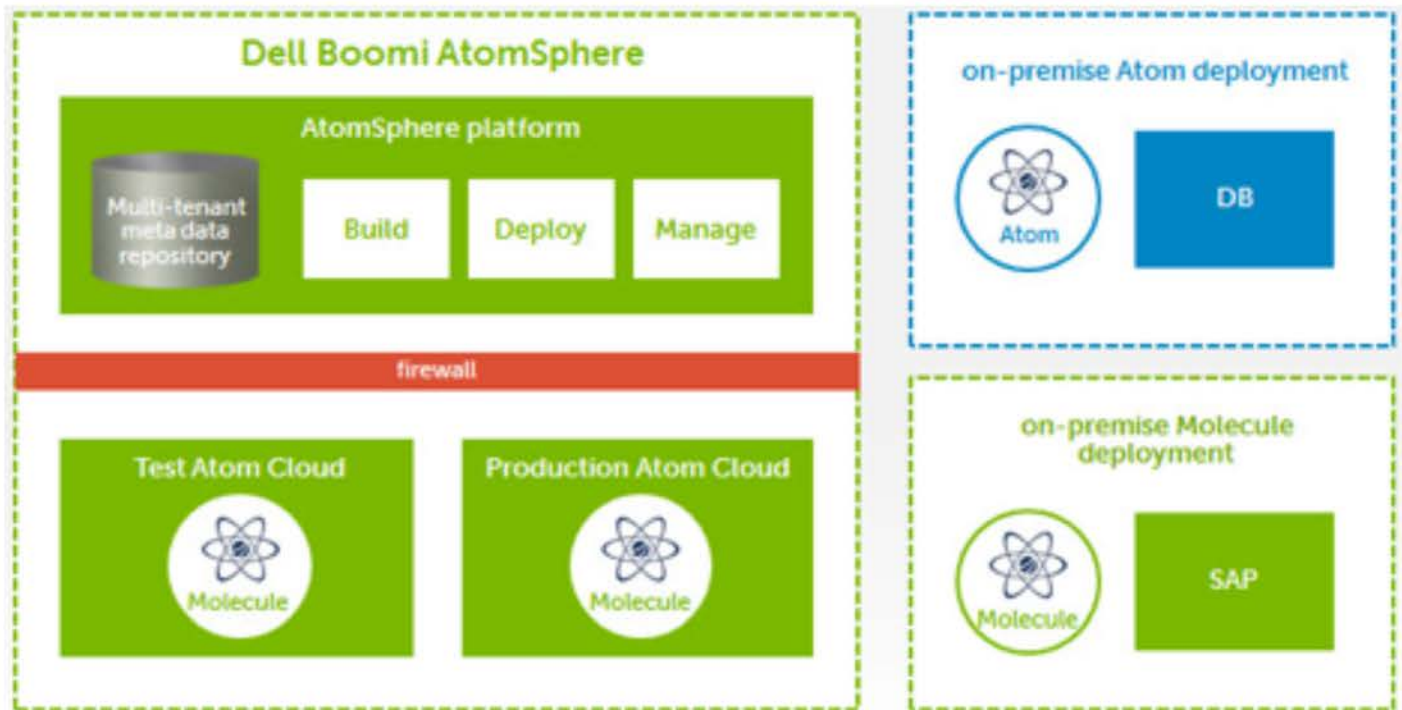
IT planners please refer to the Boomi guide after this section for deeper understanding.

<https://help.boomi.com/>

To support the on-premise model, Boomi provides a capability called an Atom, which is a lightweight Java application that is deployed on a host with Internet access.

If you use the on-premise model and want to have a highly available, load-balanced solution, or if you want to change your Atom's processing time or volume handling, or if you are worried that your Atom's processes may not run because of a computer outage, consider using a Molecule.

Boomi Deployment Model



Remember Boomi is a hybrid solution optimization, the programming of atoms and molecules is achieved with access to the AtomSphere internet configuration in a similar way to MS Azure and AWS. However, Boomi has an on-premise deployment to ensure that transactions and data related to customer operations do not leave the organization's firewall unless programmed for part of it to access 3rd party systems.

Examples can include payment gateways, time management systems and service management systems. In rare circumstances all internet is blocked even for the AtomSphere management interface, please consult with Dell Boomi for additional information. It is important to understand atoms and molecules continue operations as-built and deployed while the internet is offline, monitoring and GUI is not available until the return of internet service

Sizing considerations for Boomi

Boomi has a low resource footprint using JVM technology. Detailed configuration options can be found in the Dell Boomi documentation online.

These are some factors that go into an Atom or Molecule runtime environment setup:

> **Hardware** - the amount of memory your machine has; the number of CPUs; the amount of disk space; the number of machines you plan to use.

> **Runtime Engine** - whether you are using a single Atom or a clustered Molecule; a normal or forked execution.

> **Integration Design** - the number of sub-processes; a Flow Control shape for parallel processing; type of parallel processing (threads or processes).

It is recommended to have multi-core as a minimum within each ITS application host system. A JVM runtime is nearly supported on all ICT platforms.

Supported Operating Systems

Operating System	Version
Linux 32- and 64- bit	<ul style="list-style-type: none">> Red Hat Enterprise Linux 5.5 and above> Suse Enterprise Linux Server 10 SP2 and above> Any other Linux distribution that supports the Java 7 or 8 runtime
Windows 32- and 64- bit	<ul style="list-style-type: none">> Any other Linux distribution that supports the Java 7 or 8 runtime from Windows Vista to the most recent versions.

Minimum Hardware Requirements

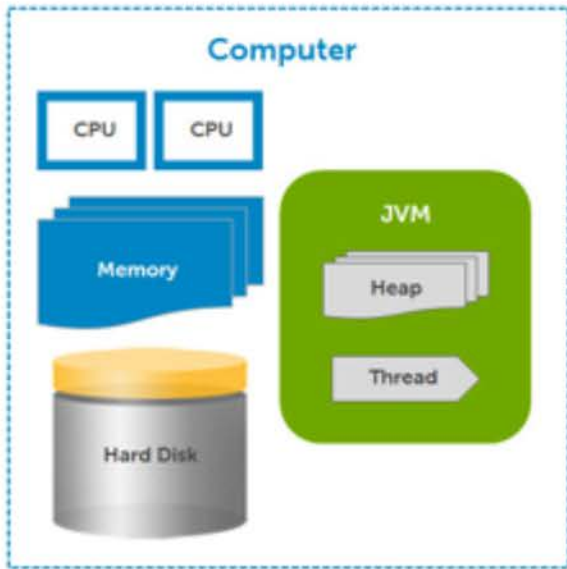
A single atom, Molecule node or Cloud Molecule within an Atom Cloud can run on hardware ranging from business-class workstations to dedicated servers.

Processor	1.8 GHz or higher Pentium 4 (or equivalent)
Memory	2 GB RAM (minimum 1 GB dedicated to Atom, Molecule node or Cloud Molecule)
Hard Disk	50 MB for run-time and configuration 10 GB for data archiving

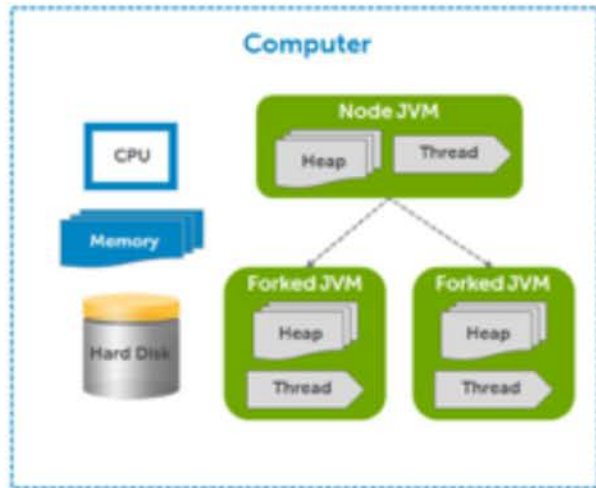
Minimum Hardware Requirements for high volume of data

A single atom, Molecule node or Cloud Molecule within an Atom Cloud that must process high volumes of data has these requirements

Processor	Dual 64-bit processors or higher
	More processors allow for increased, simultaneous executions
Memory	4 GB of RAM (minimum 2 GB dedicated to Atom, Molecule node or Cloud Molecule)
	More RAM allows for increased simultaneous process executions
Memory	100 - 200 GB of Hard Disk space
	Increase purging levels to minimize Atom, Molecule Node or Cloud Molecule disk space



For high-intensity traffic, the following may be requested for ITS ISV systems.



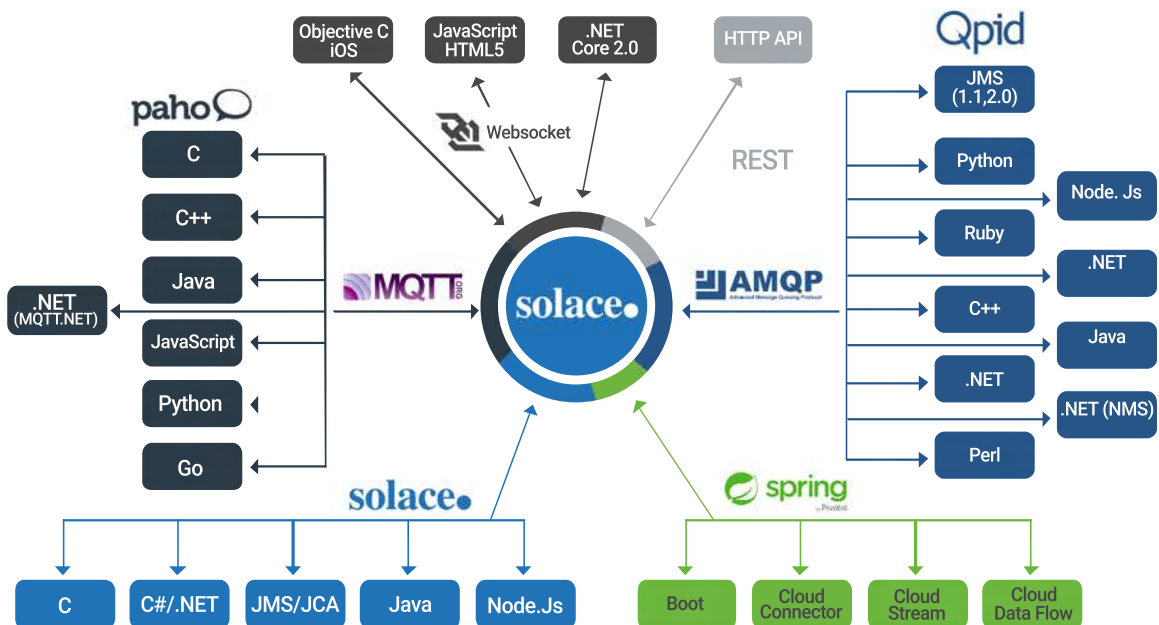
Important Design Note

In the design feasibility stage all systems needing to be accessed via Message PubSub or Boomi should be assessed for accessibility, technical suitability, approvals, PoC or Pilot testing what UAT process shall be defined.

Please note permission and verification should be sought from stakeholders of the ITS systems or service providers before attempting the installation of atoms or molecules. Data collection will need to everage access to ITS systems, consultation with vendors and operators should be covered.

PubSub systems shall have a complete assessment of all ITS applications and services which may leverage the messaging backbone. PubSub+ makes it easy to connect all kinds of applications, with no risk of lock-in, by supporting your favorite APIs and protocols. Many common protocol types are supported by Solace to support a fully integrated PubSub solution.

Solace also supports popular open protocols like AMQP, JMS, MQTT, REST and WebSocket, and open APIs such as Paho and Qpid.



The Dell Boomi and Solace team shall work in consultation for the overall design.

Price Planning Development

ITS integration programs are often cases by case sized and overall ITS complexity shall dictate a full spectrum of pricing. During the assessment stage, a clear picture can be developed, and price estimation can be provisioned depending on the diversity of outcomes desired. Careful planning of an ITS DBMR development can provide a rapid return on any investments from the resulting outcomes of unified ITS implementations.

For proof of concepts, there are very few investments required. For example, Solace provides a free license for limited standard edition and Boomi provides a free trial license of 30 days, thereafter a low-cost subscription models that can be subscribed to and unsubscribed.

We recommended in the hardware section a core system and edge broker system. Edge broker systems can be deployed for two or three thousand dollars as a rack-mount form factor, each country may obtain a quotation from Dell or its partners. Depending on the scale and needed number of brokers shall determine the total

Want to learn more?

Dell Technologies are pleased to assist partners in exploring your ITS and Urban Mobility transformation. Contact your Dell Digital Cities Representative or Dell Account Manager-Partner /for more information.

Glossary References

IOC	Integrated Operations Center
OC	Operation Center
ERP	Enterprise Resource Planning
MQTT	Message Queuing Telemetry Transport