mesh dynamics

Challenge:

Legacy and IOT Integration with

- *Scalability*
- *Synchronicity*

- *Security, Standards, Simplicity*

Introducing: The Abstracted Network

Challenge: Different needs for Legacy and IoT

- Billions of legacy controllers, appliances, actuators, and sensors.
  Integration of legacy protocols and supporting deterministic latencies etc.
- Enterprises also want to extend SDN-like capabilities to edge
  Silos must be integrated and addressable within framework
- Emerging IoT applications will involve *trillions* of new devices.
  Some, too dumb, cheap and copious to manage via traditional means
- IP can't be the *lingua franca for all.* New Protocols will evolve.
  Many devices may lack memory, processor – and be unmanageable

Challenges

- How to keep systems O(n) scalable ?
- How to keep performance (latency) predictable?

Challenge: Scalability and Synchronicity

- Performance – must solve $O(n^2)$ problem

  Proposed: tree based mesh network routing overhead is O (n)

- Management – extending Enterprise tools via SDN

  Proposed: M2M communications need Device/Protocol Abstractions.

- Control Loop Latencies for round trip (device to Cloud)

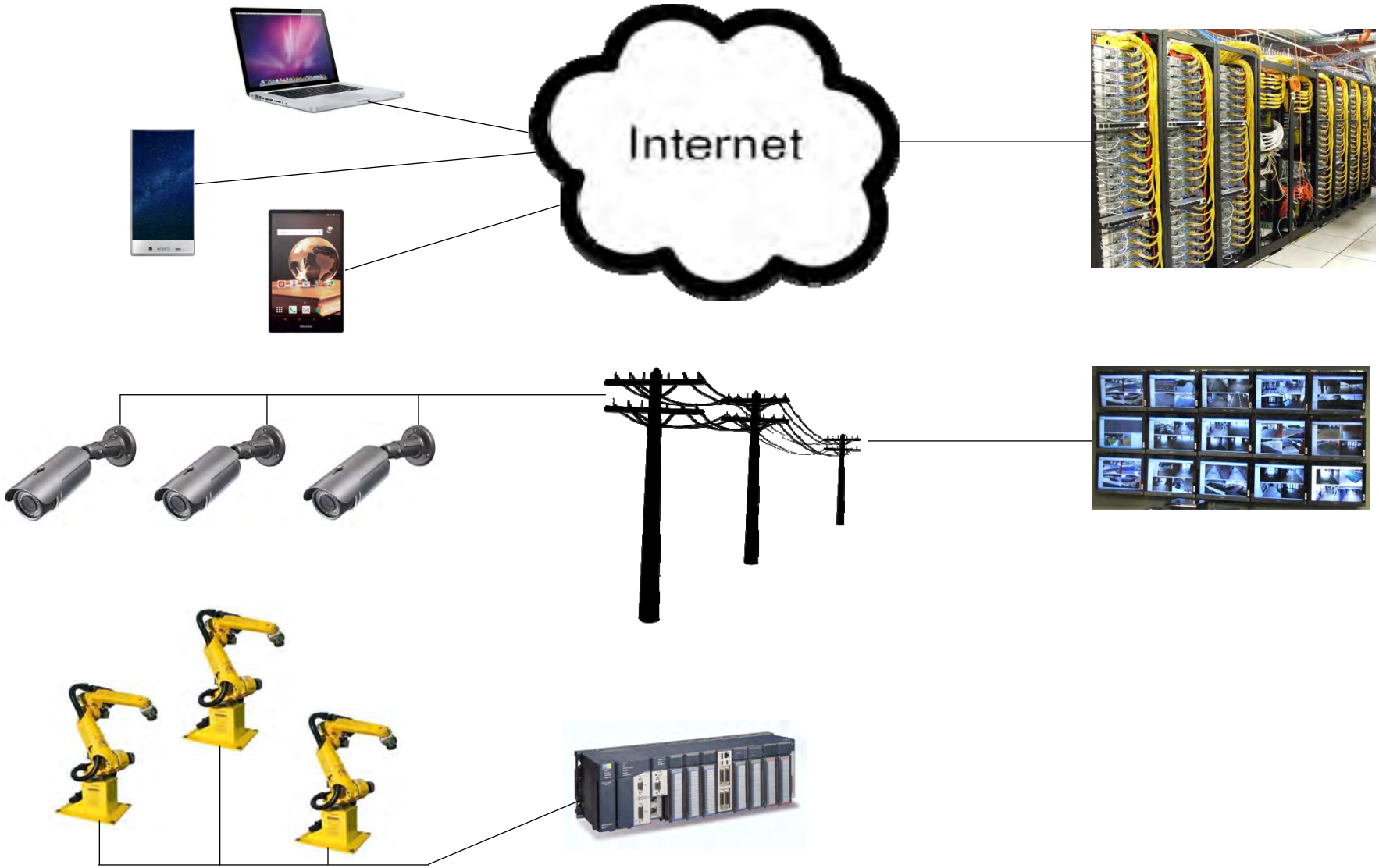
  Proposed: Uncouple local response loops from enterprise-wide round-trip

  Proposed: Time Sensitive Publish/discover/subscribe architecture

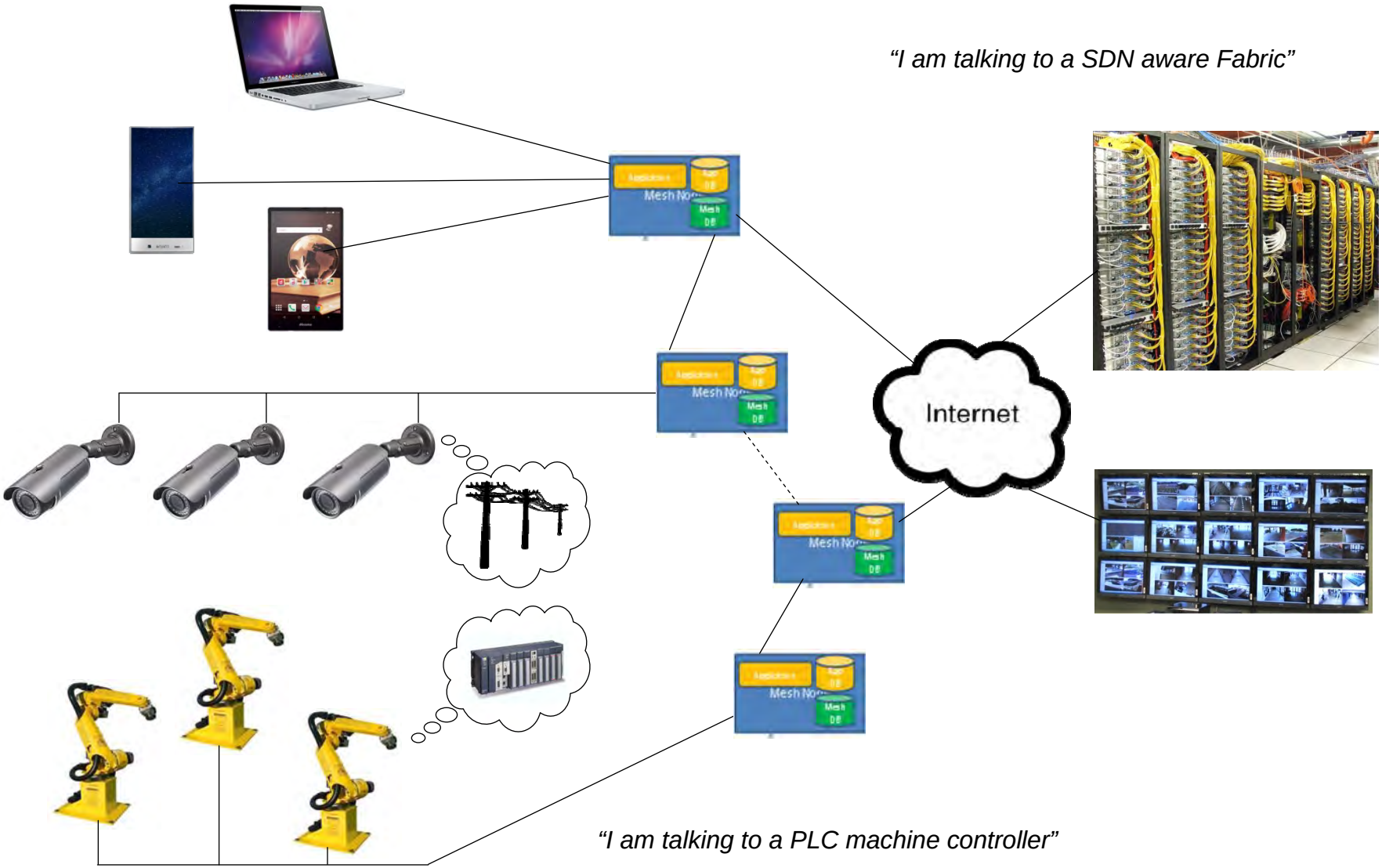
- Scope – can't address billion device individually

  Proposed: Dumber devices, smarter edge "machine controllers"

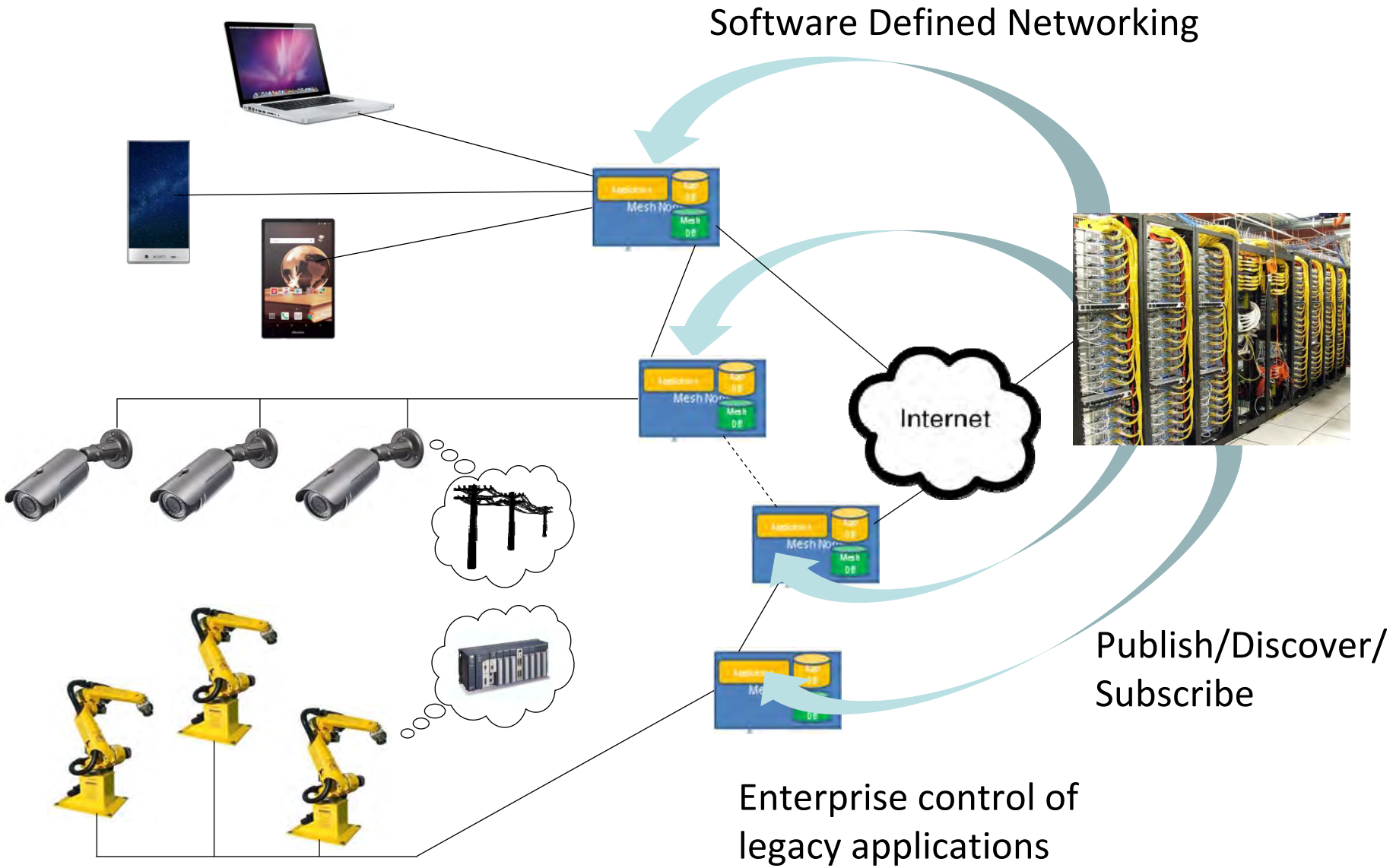
Traditional Networks Separate



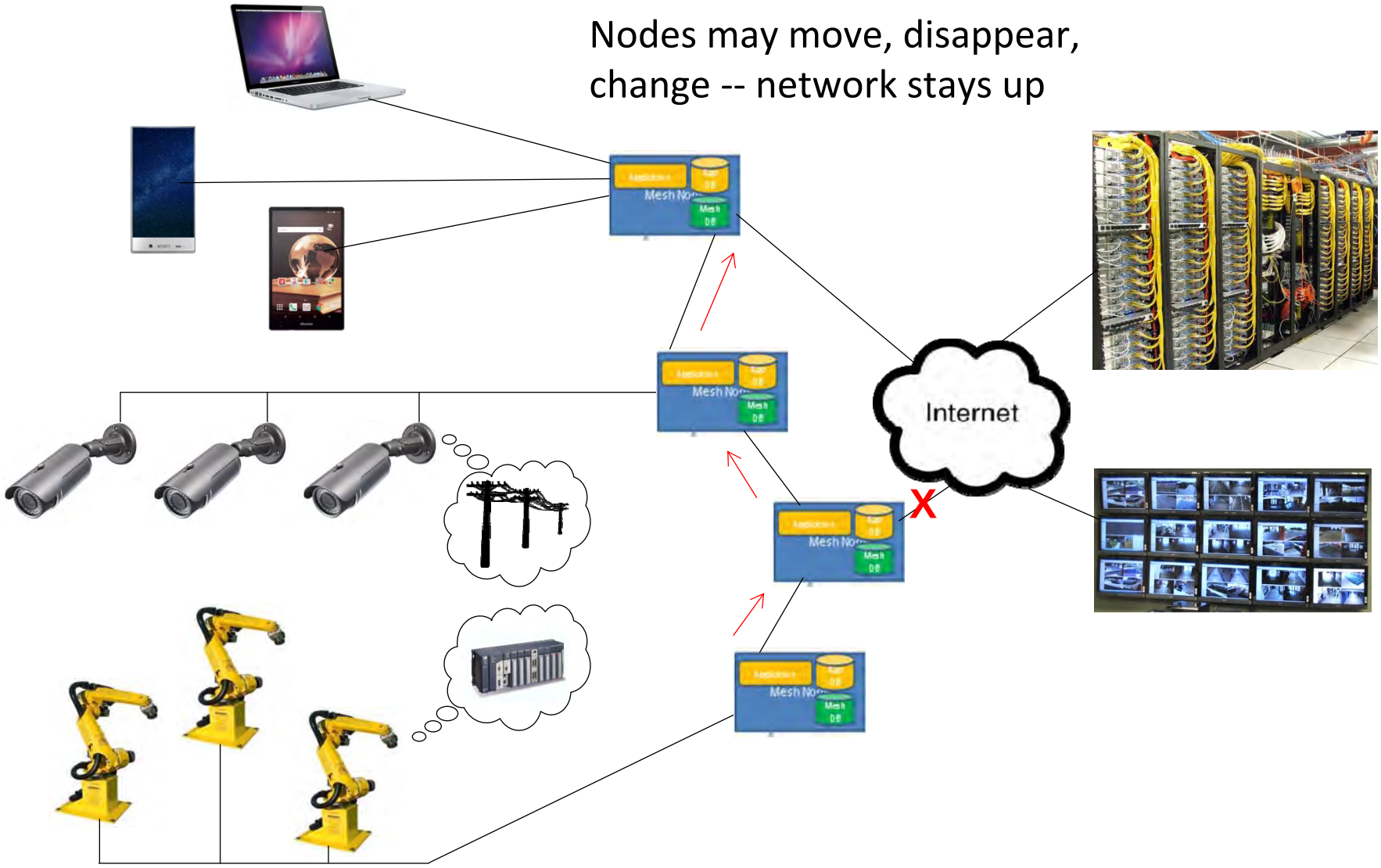
Abstracted Network Emulates Separate Networks



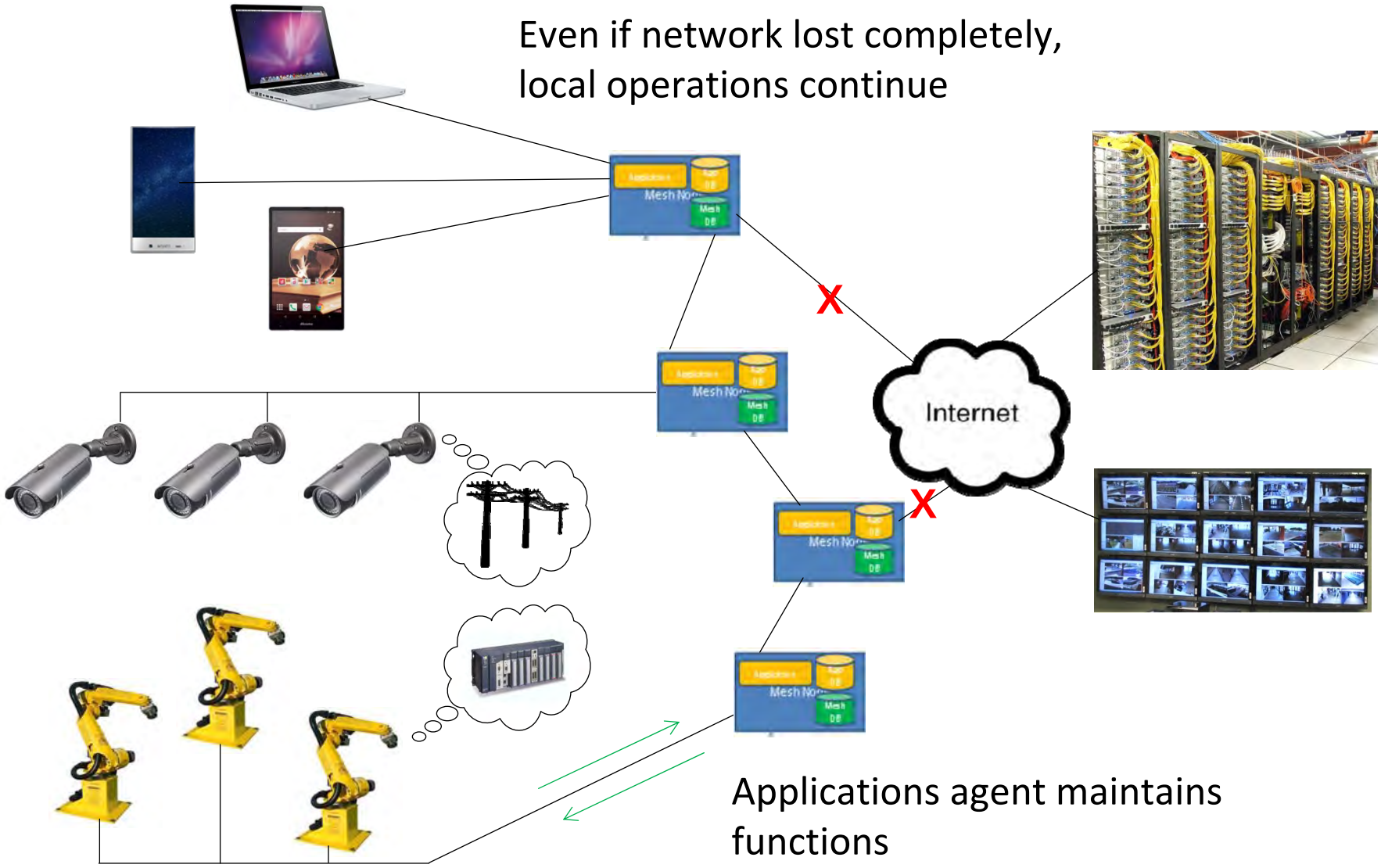
Abstracted Network Offers Enterprise Tools Everywhere



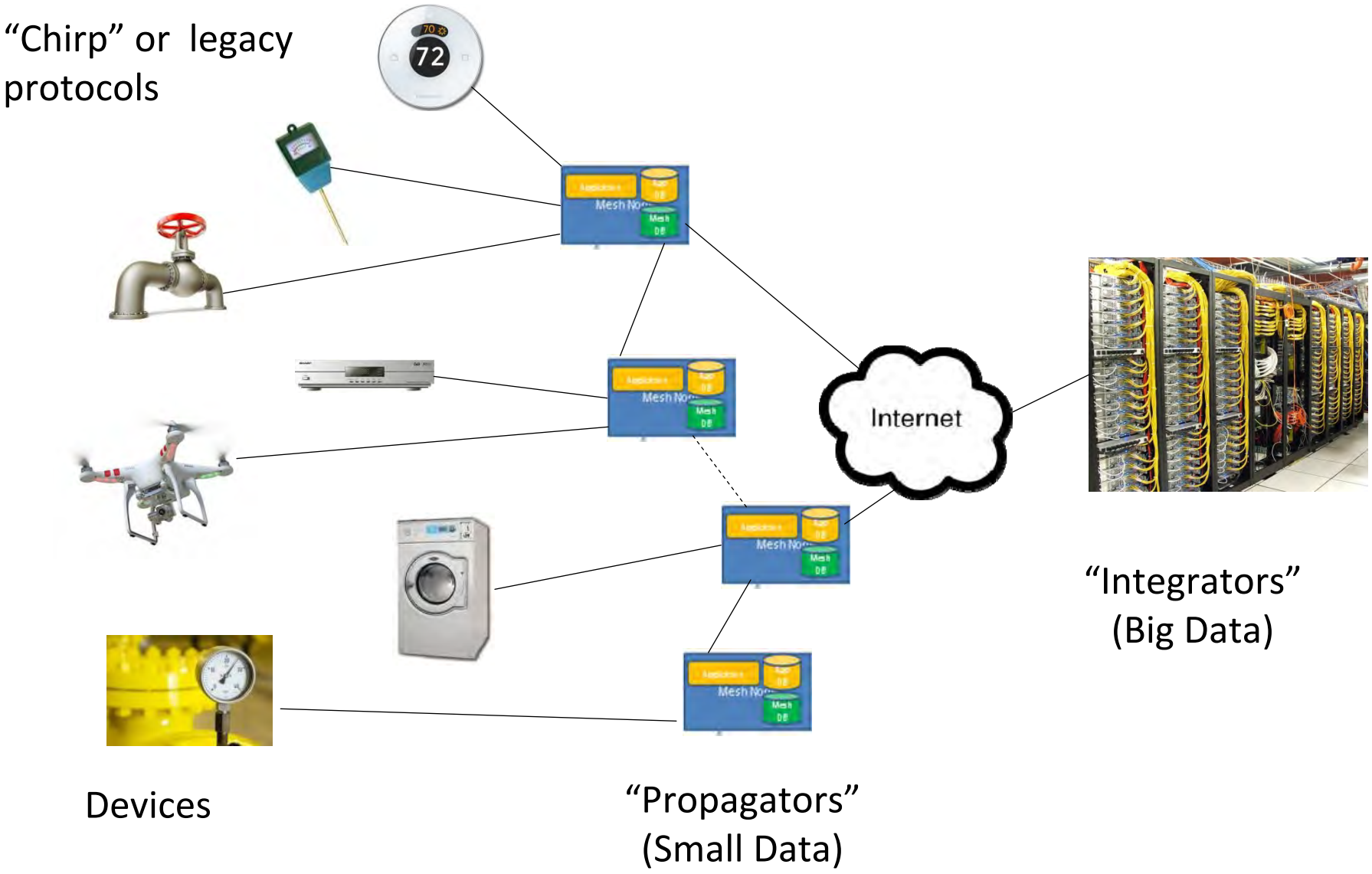
Disruption Tolerance Maintains Connections



Disruption Tolerance Maintains Operation



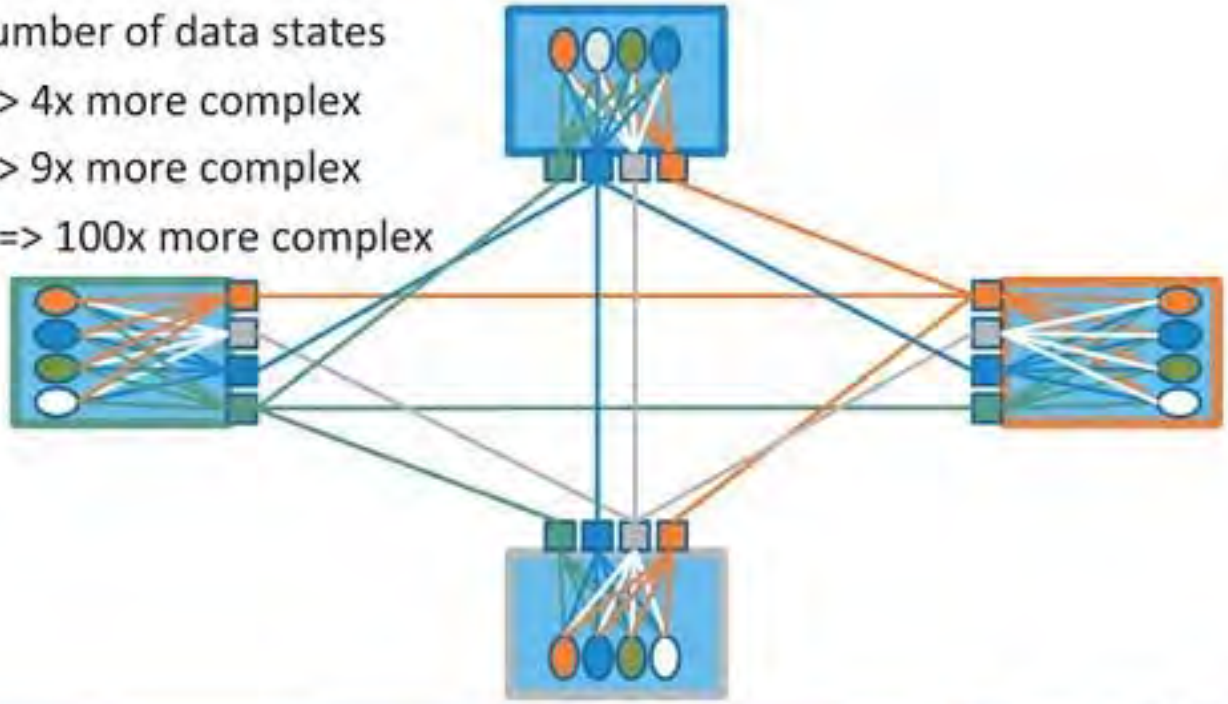
Abstracted Network Connects Old and New IOT Devices



Challenge: M2M Messaging cannot be O(n^2)

Application-Centric Development

- O (n^2) Scaling '
  - **n** is the number of data states
  - 2x state => 4x more complex
  - 3x state => 9x more complex
  - 10x state => 100x more complex

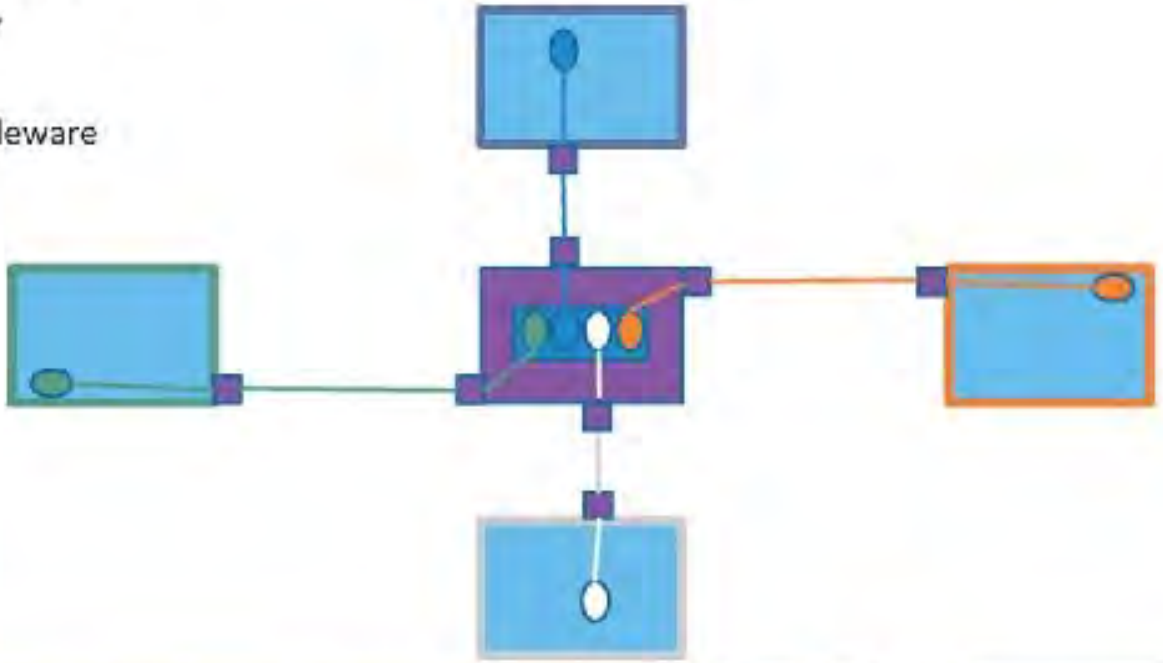


From SLIC-RTI-Barcelona

Data Driven M2M Messaging Scale O(n)

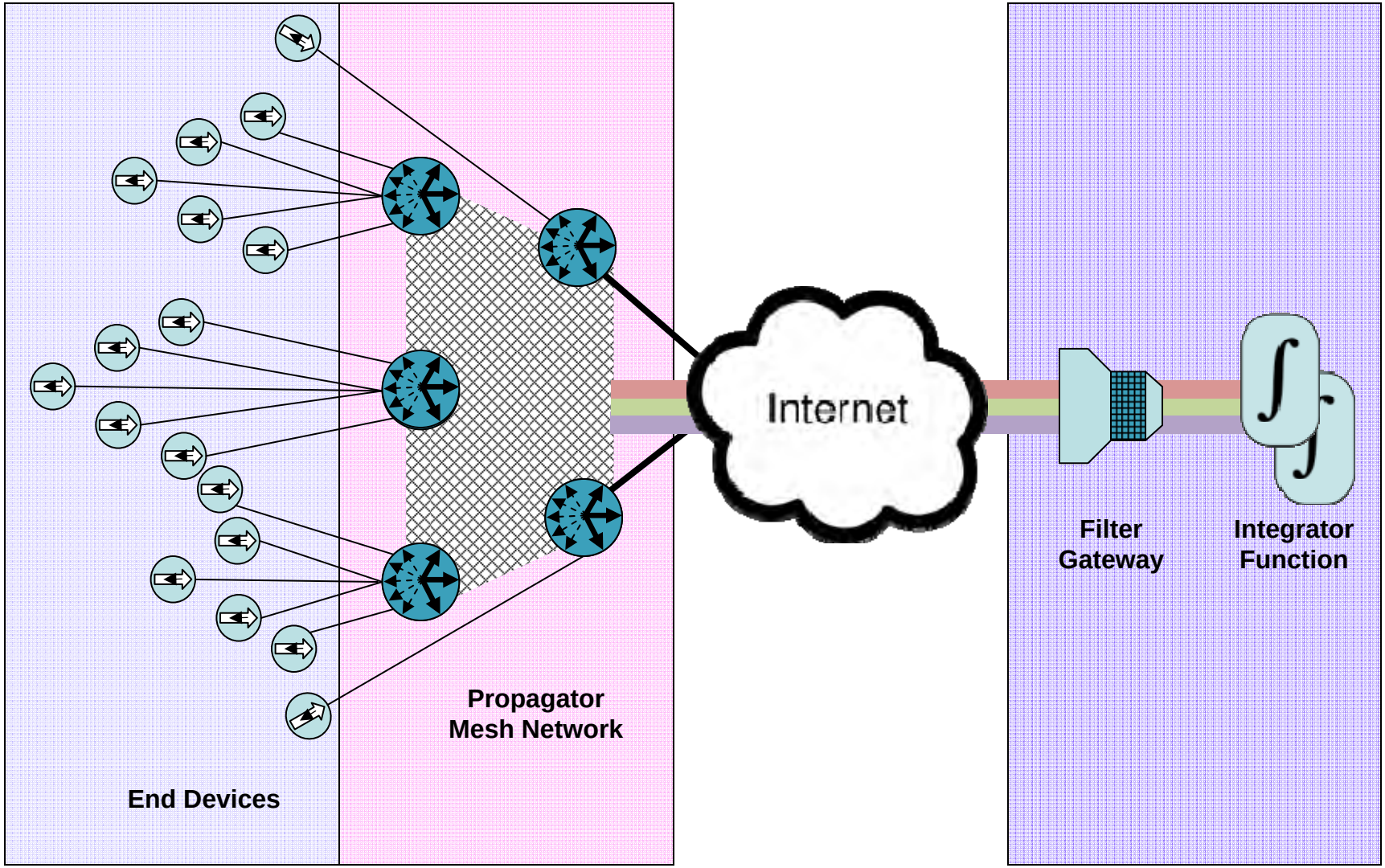
Data-Centric Development

- Delegate state to middleware
  - Enables interoperability
  - Scales O(n)
  - State synced with middleware



From SLIC-RTI-Barcelona

O(n) Scalable, Physical, Tree, Mesh Network



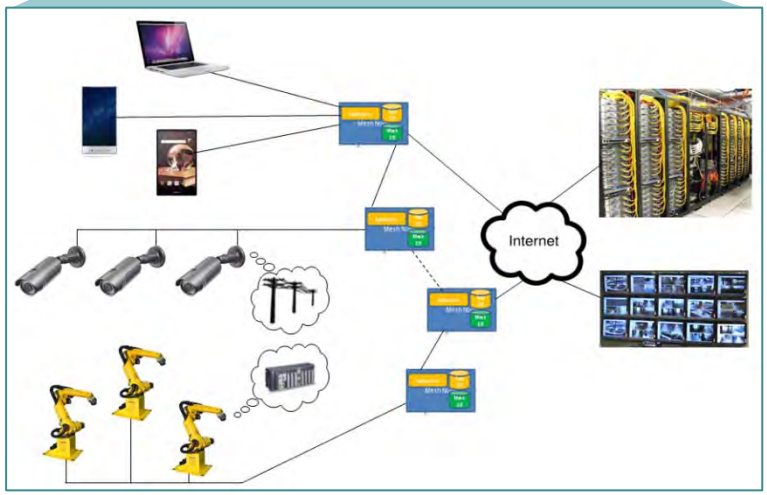
Chirp Data Streams **"Small" Data Flows** **"Big Data" Analysis**

App Database Maintains App Requirements

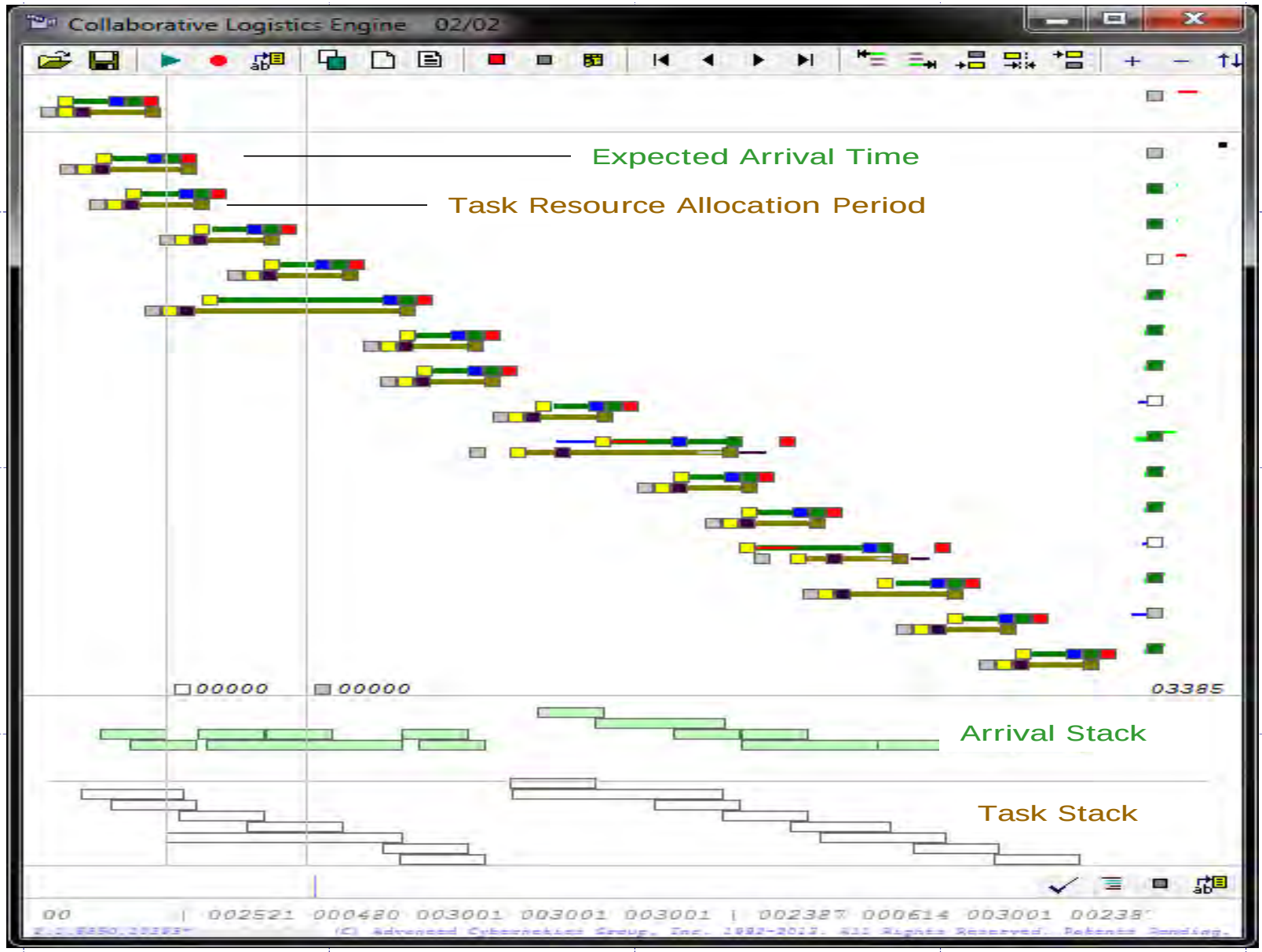
ID	SubjectName	TrialSequence	Time	PupilDiaX	PupilDiaY	GazePosX	GazePosY
1102	VPN01	0	4608	4,120000	3,880000	531,349976	279,390015
1103	VPN01	0	4612	4,170000	3,880000	527,559998	279,500000
1104	VPN01	0	4616	4,110000	3,880000	527,570007	278,399994
1105	VPN01	0	4620	4,120000	3,880000	526,969971	278,420013
1106	VPN01	0	4625	4,120000	3,880000	527,549988	278,399994
1107	VPN01	0	4629	4,120000	3,880000	525,559998	279,380005
1108	VPN01	0	4633	4,110000	3,880000	525,239990	279,630005
1109	VPN01	0	4637	4,120000	3,880000	525,099976	280,049988
1110	VPN01	0	4641	4,110000	3,880000	525,950012	280,029999
1111	VPN01	0	4646	4,110000	3,880000	524,630005	280,070007
1112	VPN01	0	4650	4,120000	3,880000	524,440002	282,649994
1113	VPN01	0	4654	4,120000	3,880000	522,159973	282,720001
1114	VPN01	0	4658	4,120000	3,880000	521,770020	280,140015
1115	VPN01	0	4662	4,110000	3,880000	526,320007	278,420013
1116	VPN01	0	4666	4,070000	3,880000	528,700012	277,510010
1117	VPN01	0	4671	4,070000	3,880000	526,989990	275,890015
1118	VPN01	0	4675	4,070000	3,880000	522,530029	276,380005
1119	VPN01	0	4679	4,060000	3,880000	524,140015	276,329987
1120	VPN01	0	4683	4,070000	3,880000	524,150024	275,500000
1121	VPN01	0	4687	4,070000	3,880000	524,109985	279,200012
1122	VPN01	0	4692	4,120000	3,880000	525,500000	279,589996
1123	VPN01	0	4696	4,070000	3,880000	524,159973	277,369995
1124	VPN01	0	4700	4,070000	3,880000	524,150024	278,109985
1125	VPN01	0	4704	4,070000	3,920000	524,619995	278,230011
1126	VPN01	0	4708	4,070000	3,880000	524,619995	278,230011
1127	VPN01	0	4712	4,070000	3,880000	524,619995	278,019989

Manage:

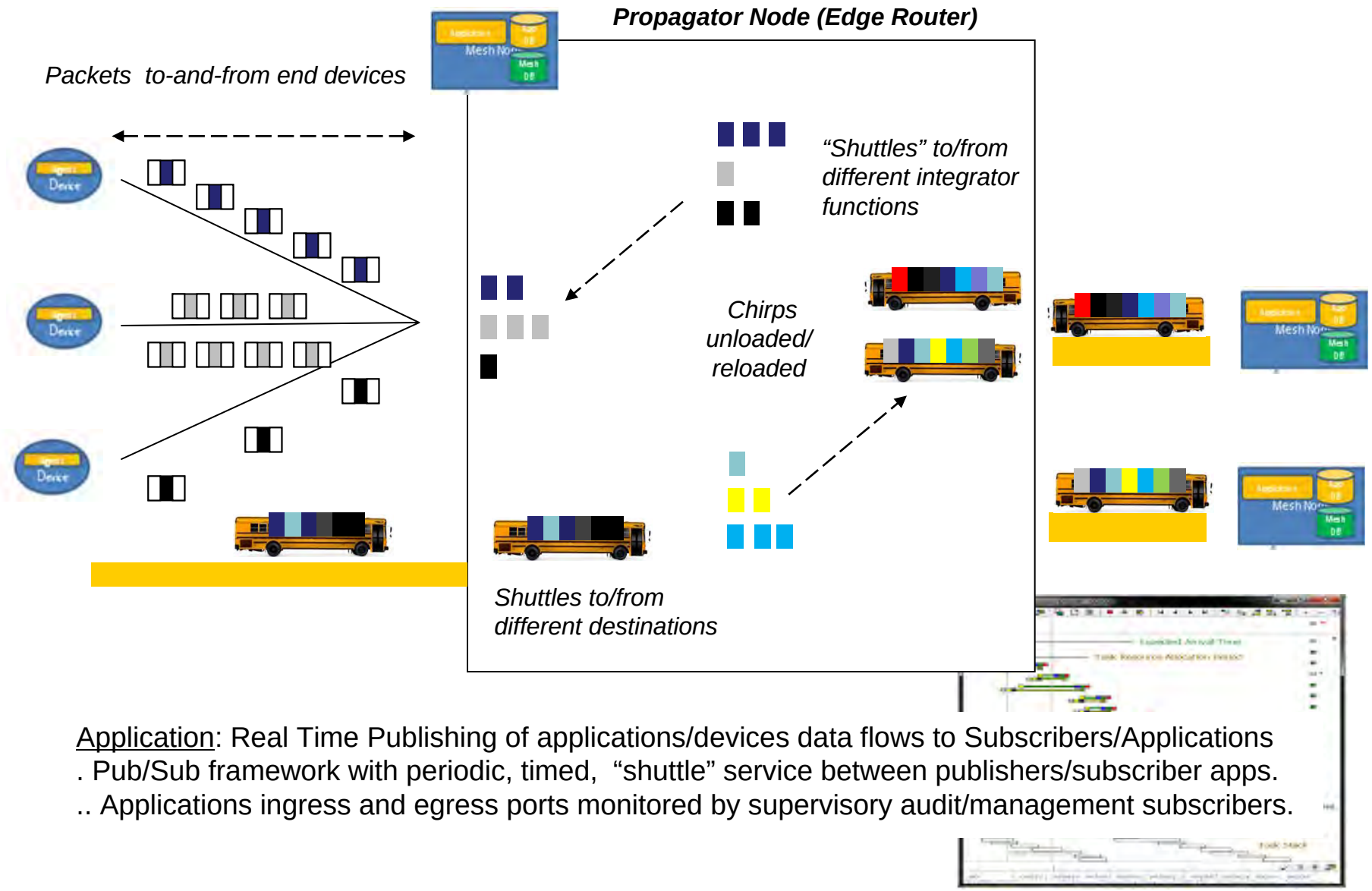
- Latency/Jitter
- Discovery
- Multicast
- Control Loops
- Protocol Translation



Managing M2M Application Latency (Scheduling)



Latency Sensitive M2M Pub/Sub Messaging



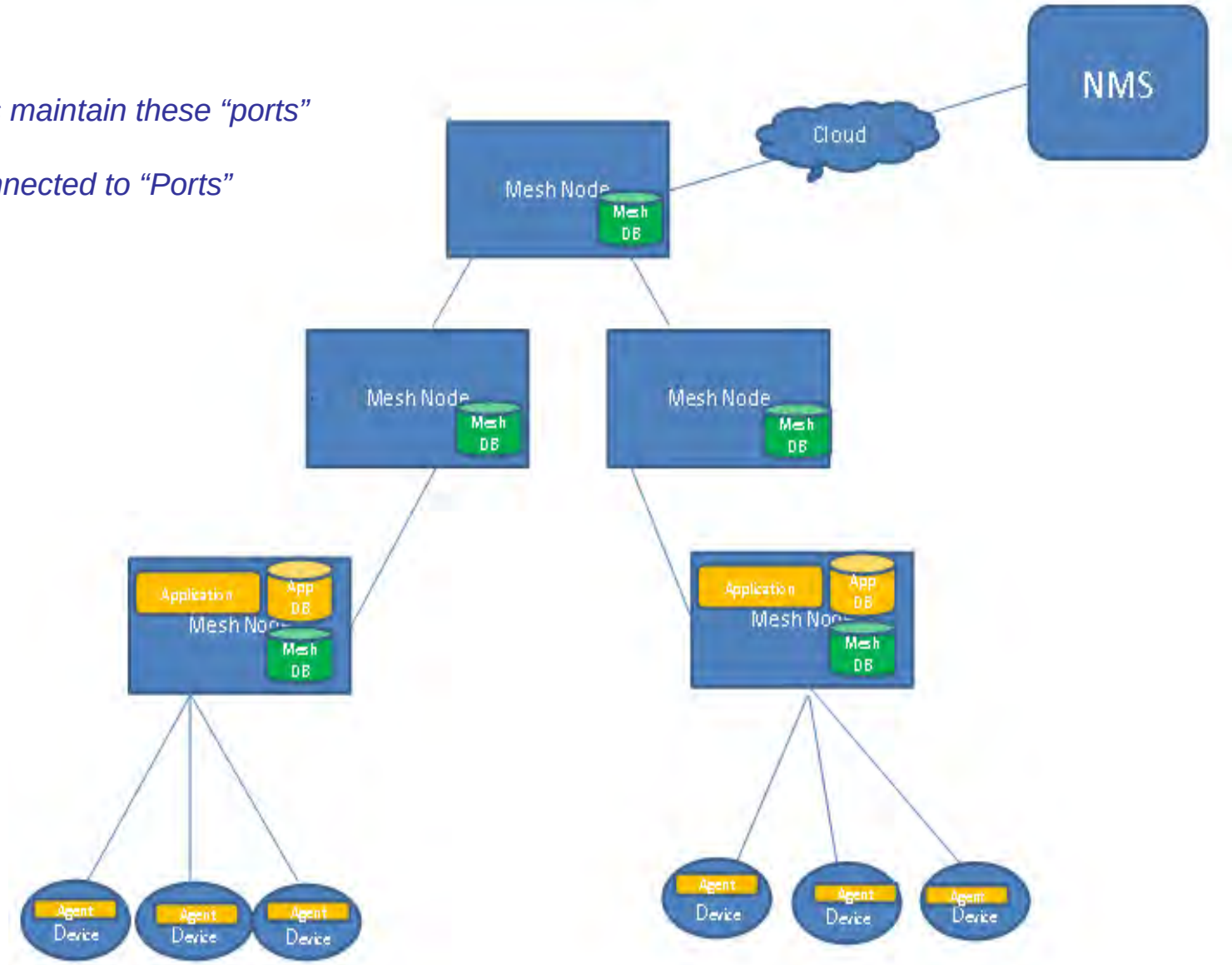
Application: Real Time Publishing of applications/devices data flows to Subscribers/Applications
. Pub/Sub framework with periodic, timed, "shuttle" service between publishers/subscriber apps.
.. Applications ingress and egress ports monitored by supervisory audit/management subscribers.

mesh dynamics (Autonomous) Applications Running on Mesh Node

Mesh Tables maintain these "ports"

.. Clients connected to "Ports"

..

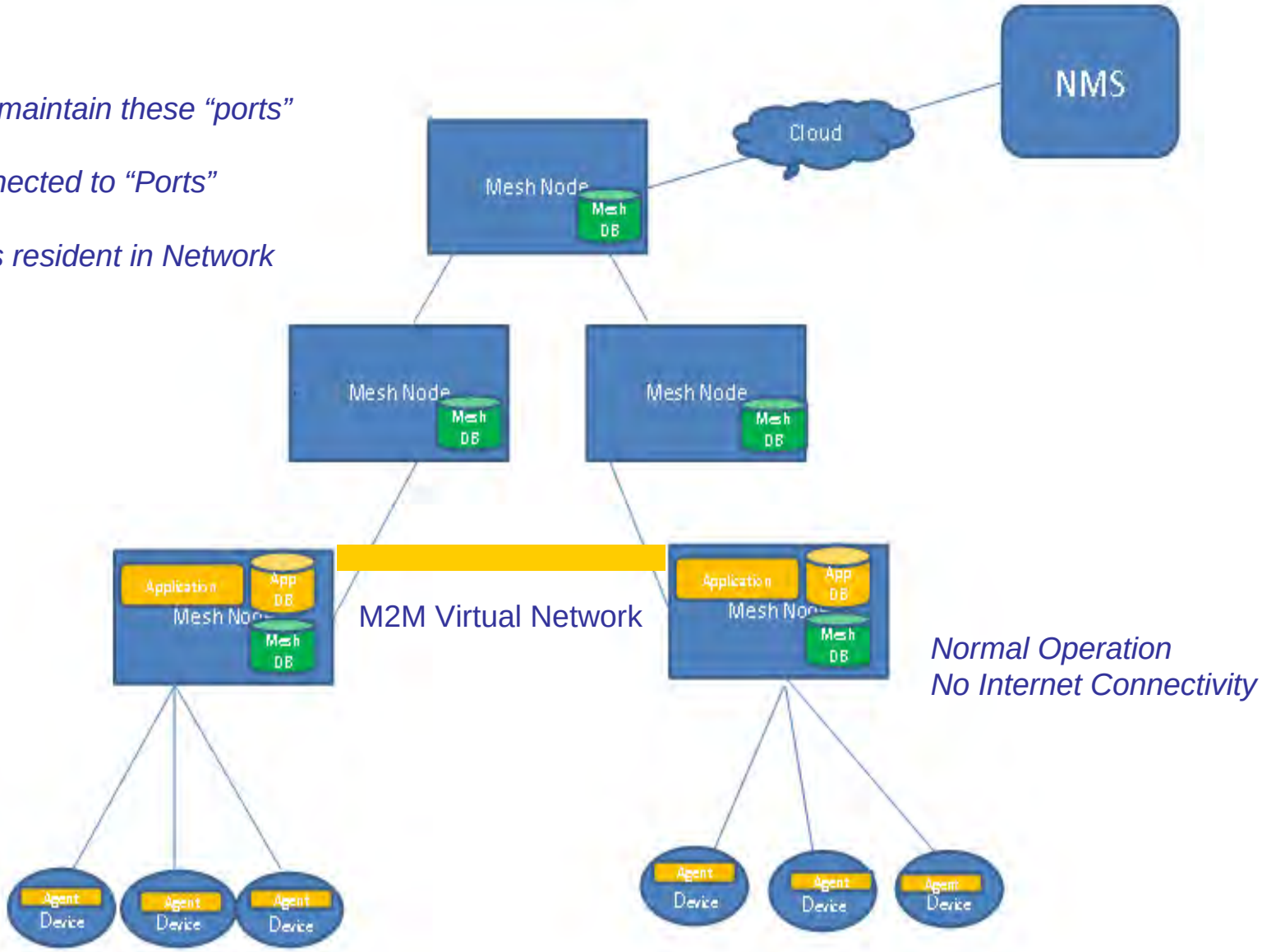


mesh dynamics (Autonomous) Applications Running on Mesh Node

Mesh Tables maintain these "ports"

.. Clients connected to "Ports"

.. Applications resident in Network



Normal Operation
No Internet Connectivity

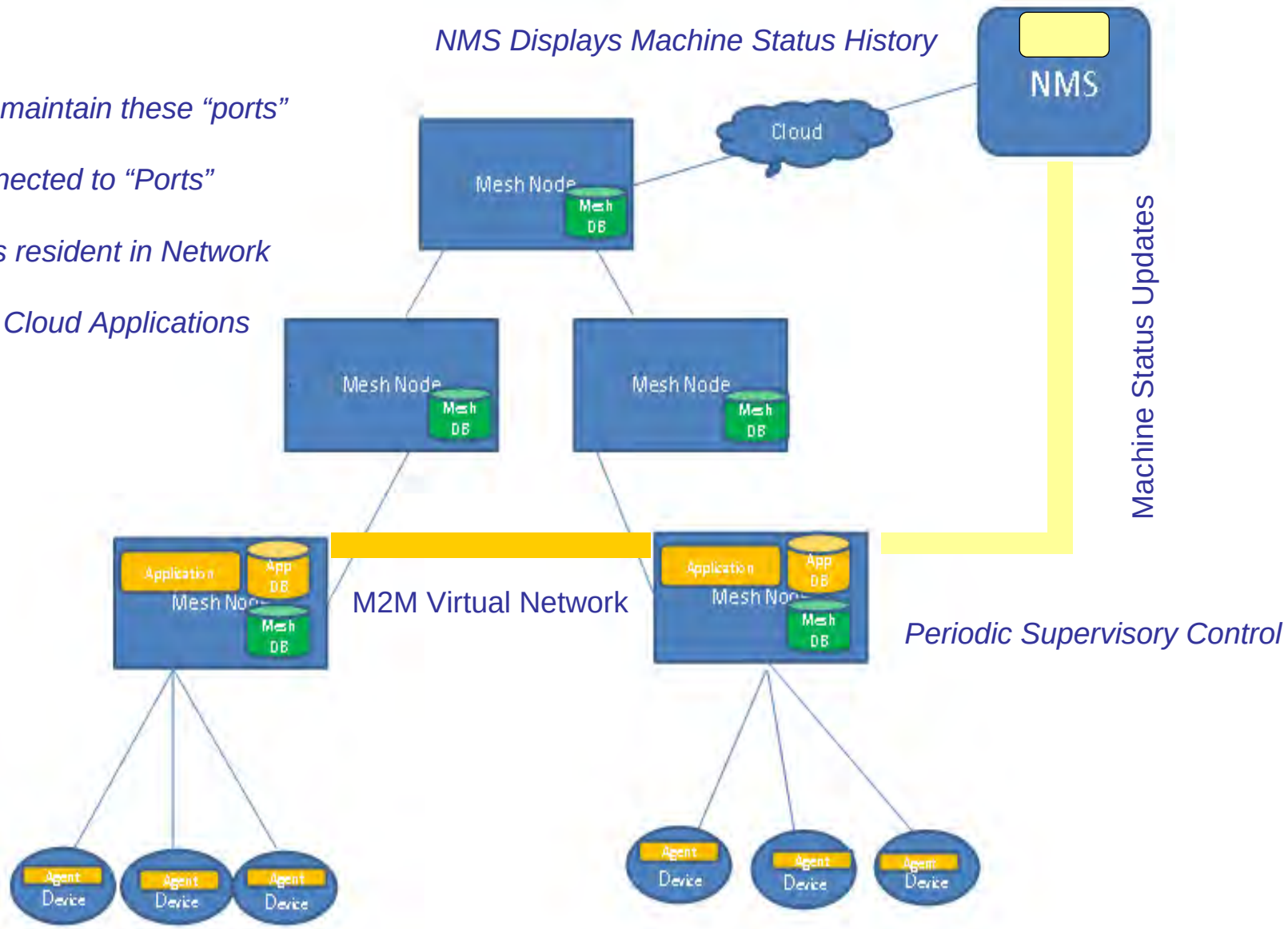
(Autonomous) Applications Running on Mesh Node

Mesh Tables maintain these "ports"

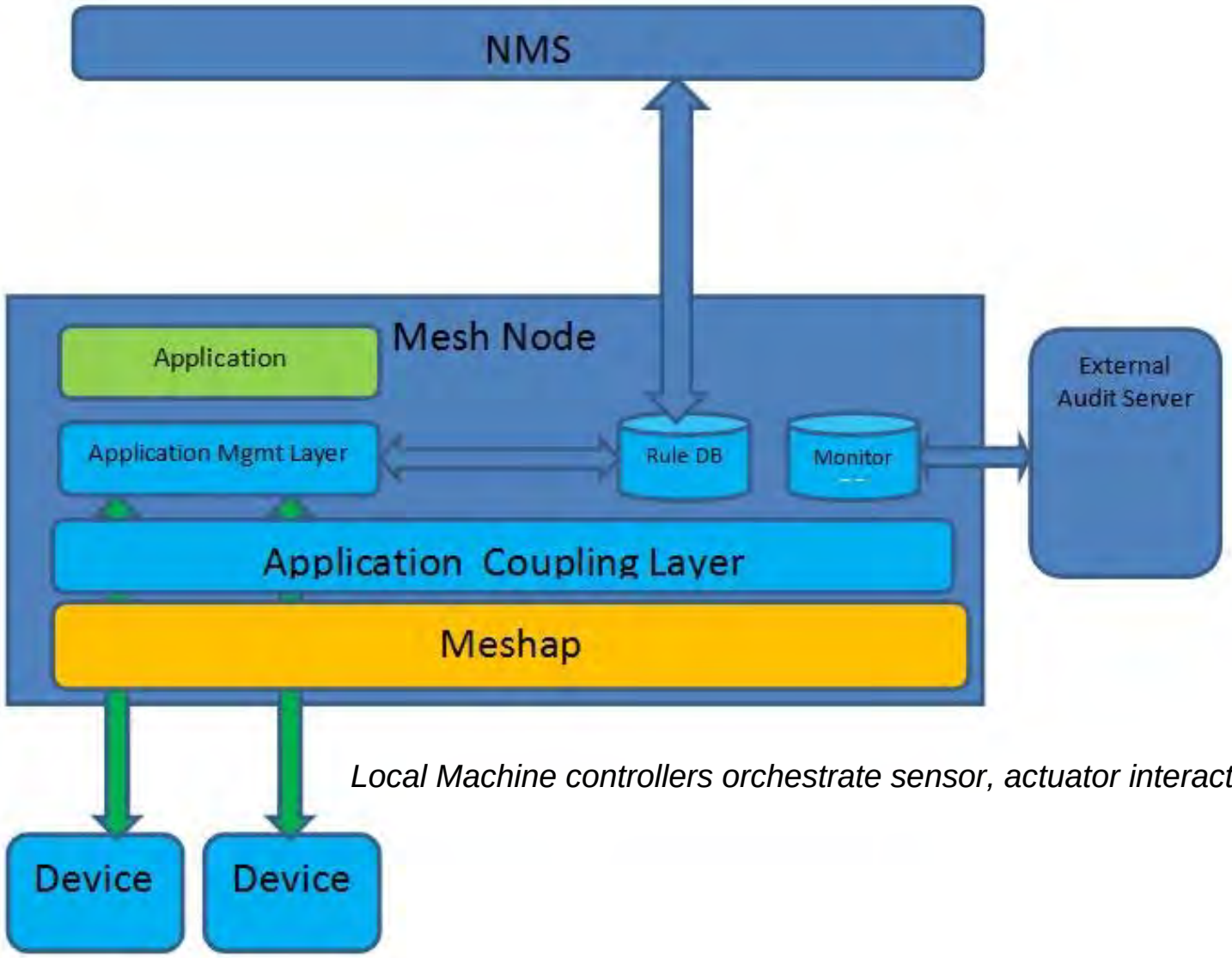
.. Clients connected to "Ports"

.. Applications resident in Network

.. Intermittent Cloud Applications

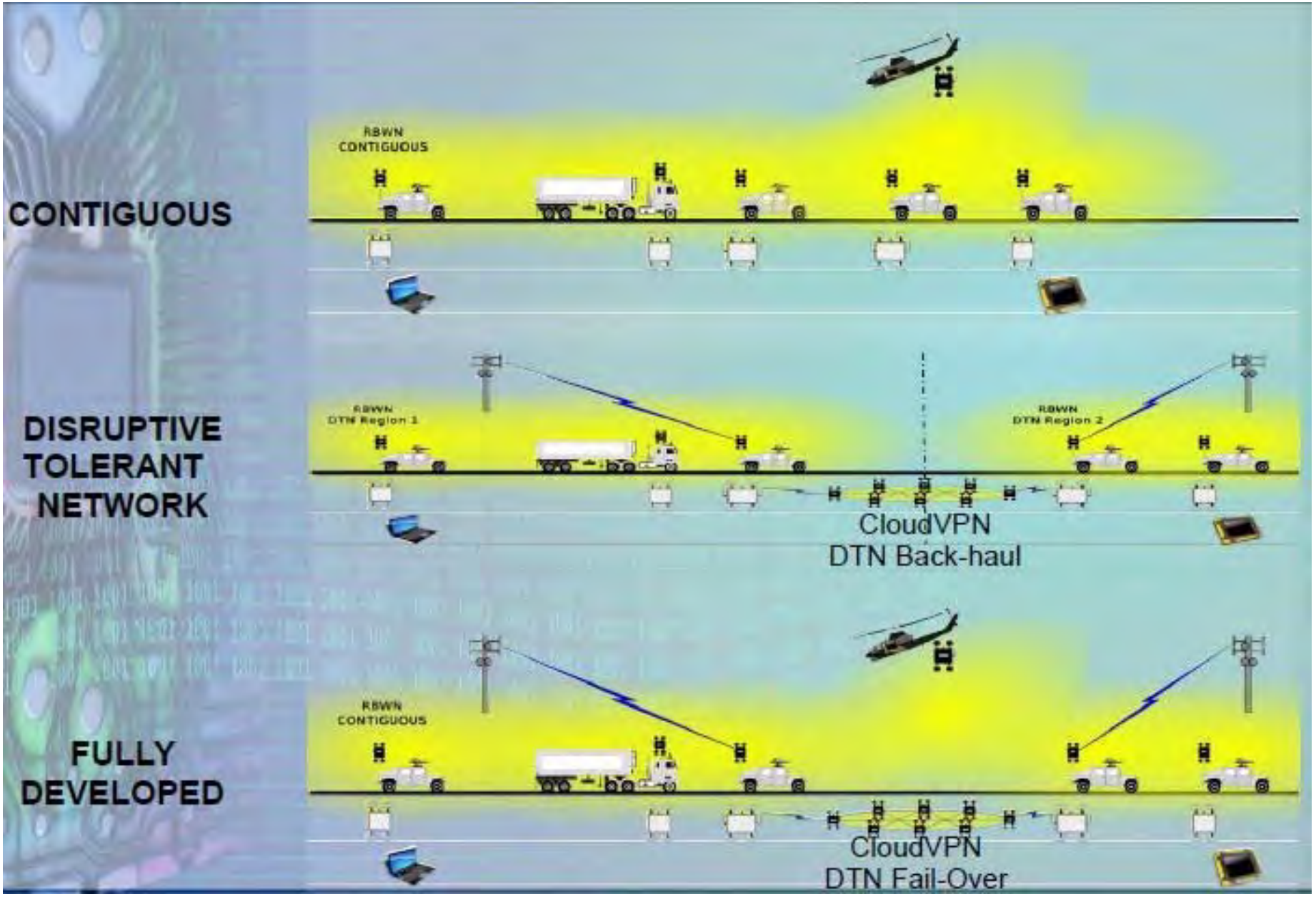


Synchronicity: M2M over a Scalable O(n) Arch.

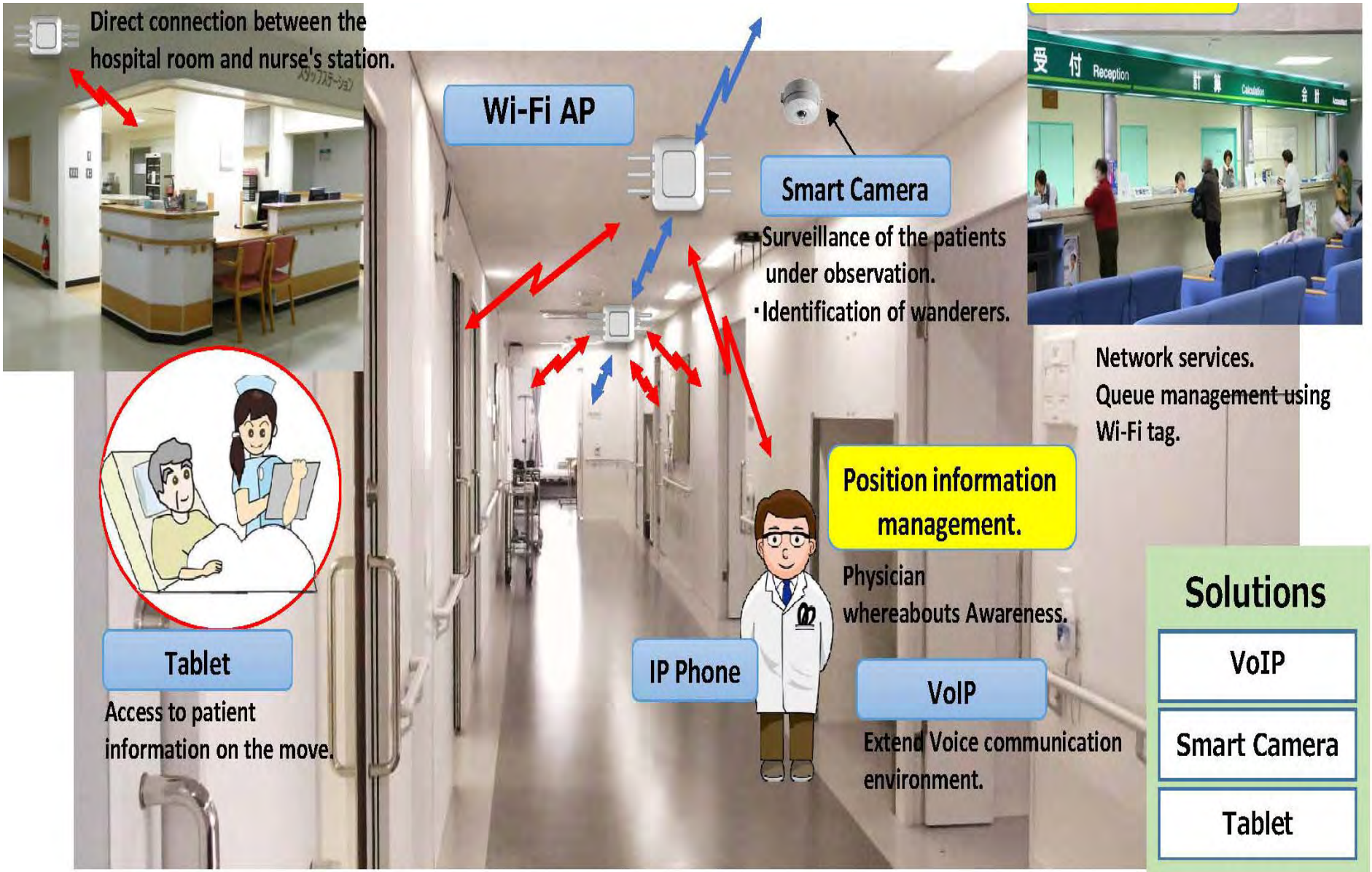


Local Machine controllers orchestrate sensor, actuator interactions

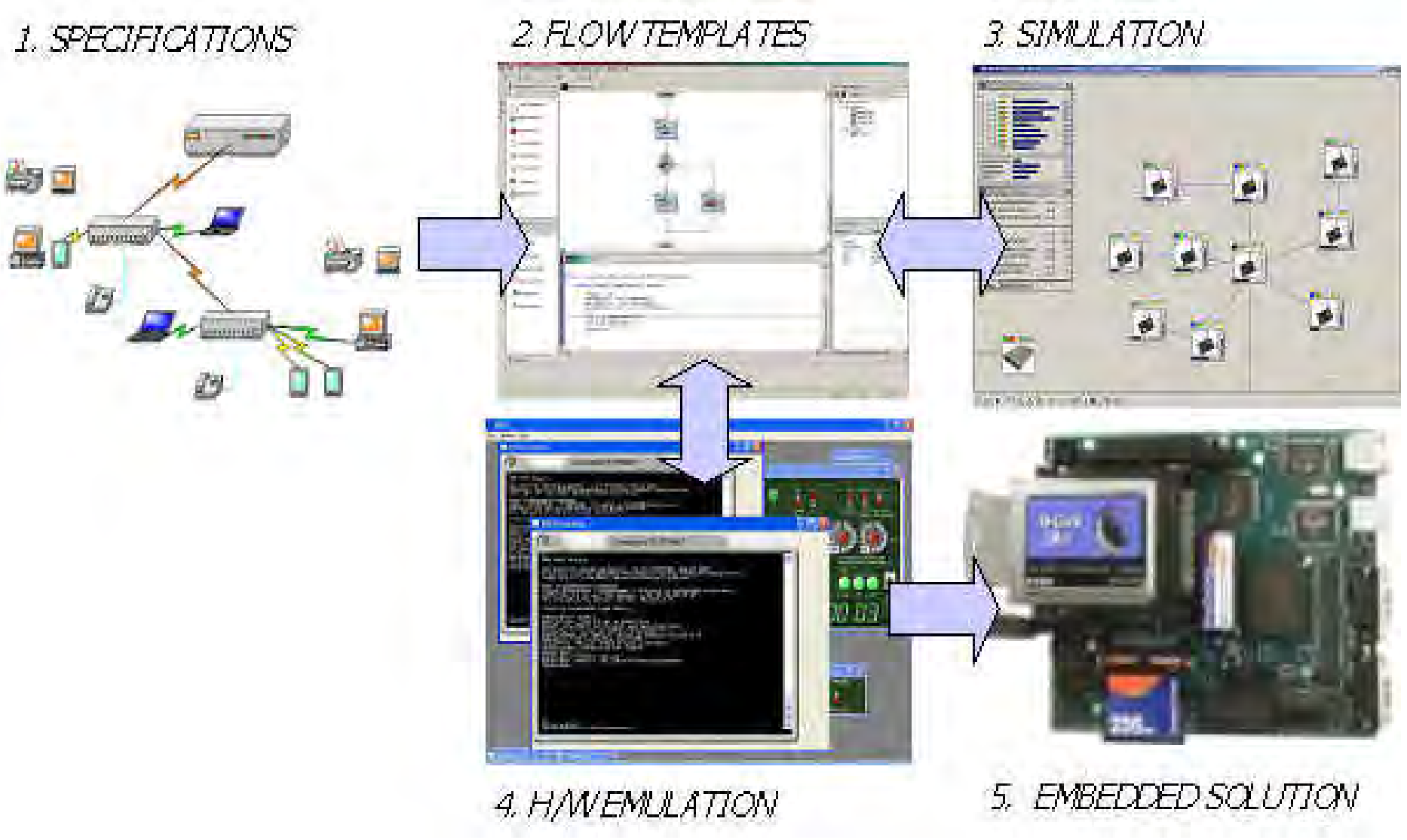
SPAWAR (US Navy) Disruption Tolerant Network



Sharp Electronics Robust Hospital Network



Objectives of Autonomous Network Test Bed



Links and References

1. *The Abstracted Network*

   www.meshdynamics.com/documents/ABSTRACTED-NETWORK-FOR-IOT.pdf

2. *Chirp Networks*

   www.meshdynamics.com/Patents/US09258765_B1_CN_020916.PDF

3. *Rethinking the Internet of Things (APress Publications)*

   www.meshdynamics.com/documents/Rethinking-Internet-Of-Things-Book.pdf