Seacoast Industrial Internet

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IoT Backhaul/Network Options and Issues

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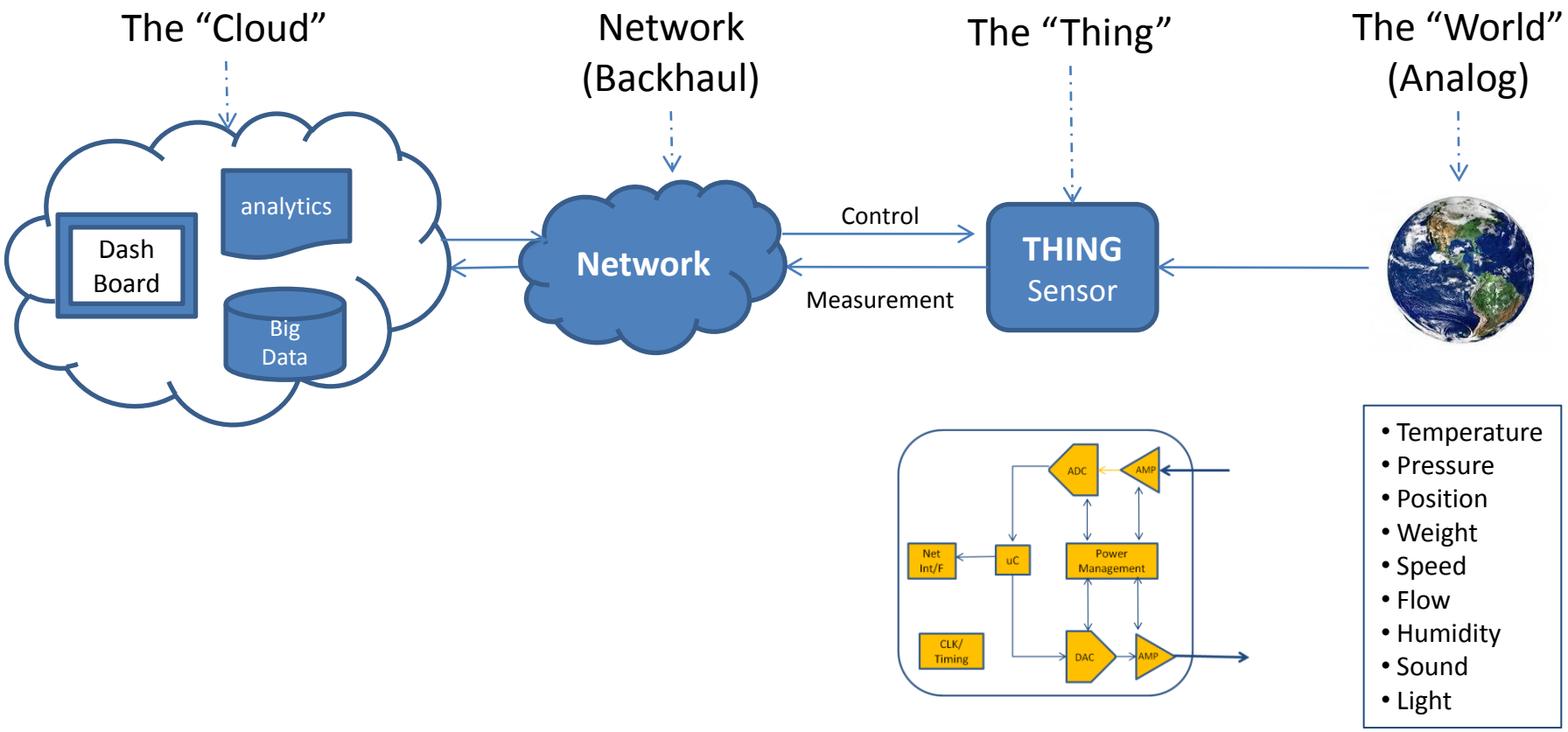
Thanks to: Alpha Loft innovation | commercialization | acceleration
SIGHT MACHINE

Overview

- Discuss the networking aspects of IoT applications
- Review the various options available
- Generate discussion and ideas

IoT: The Basics



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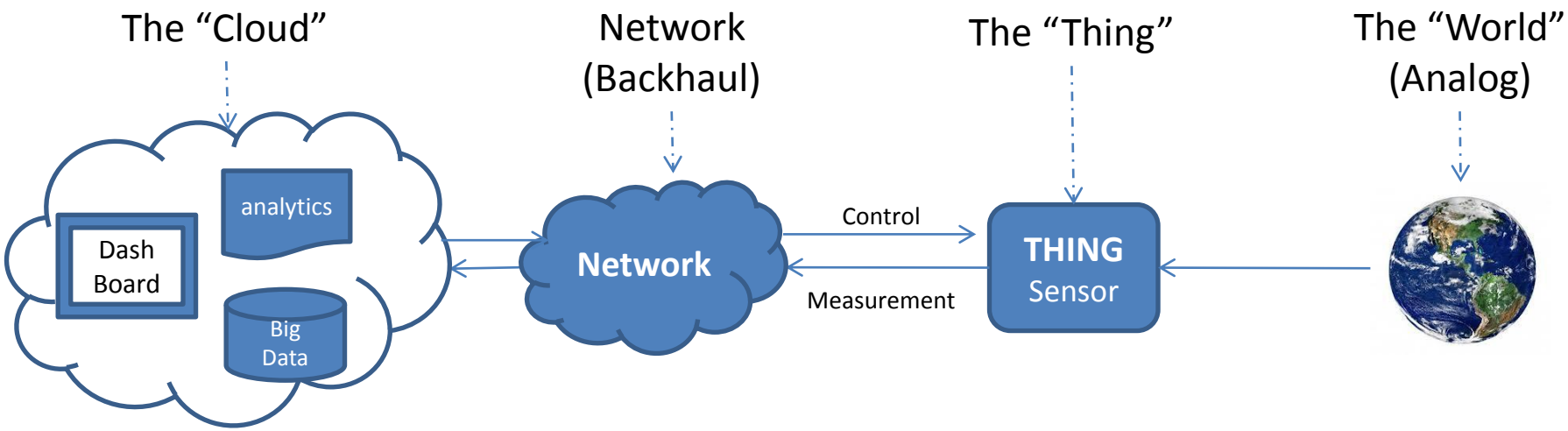


Intelligence (I) Distribution

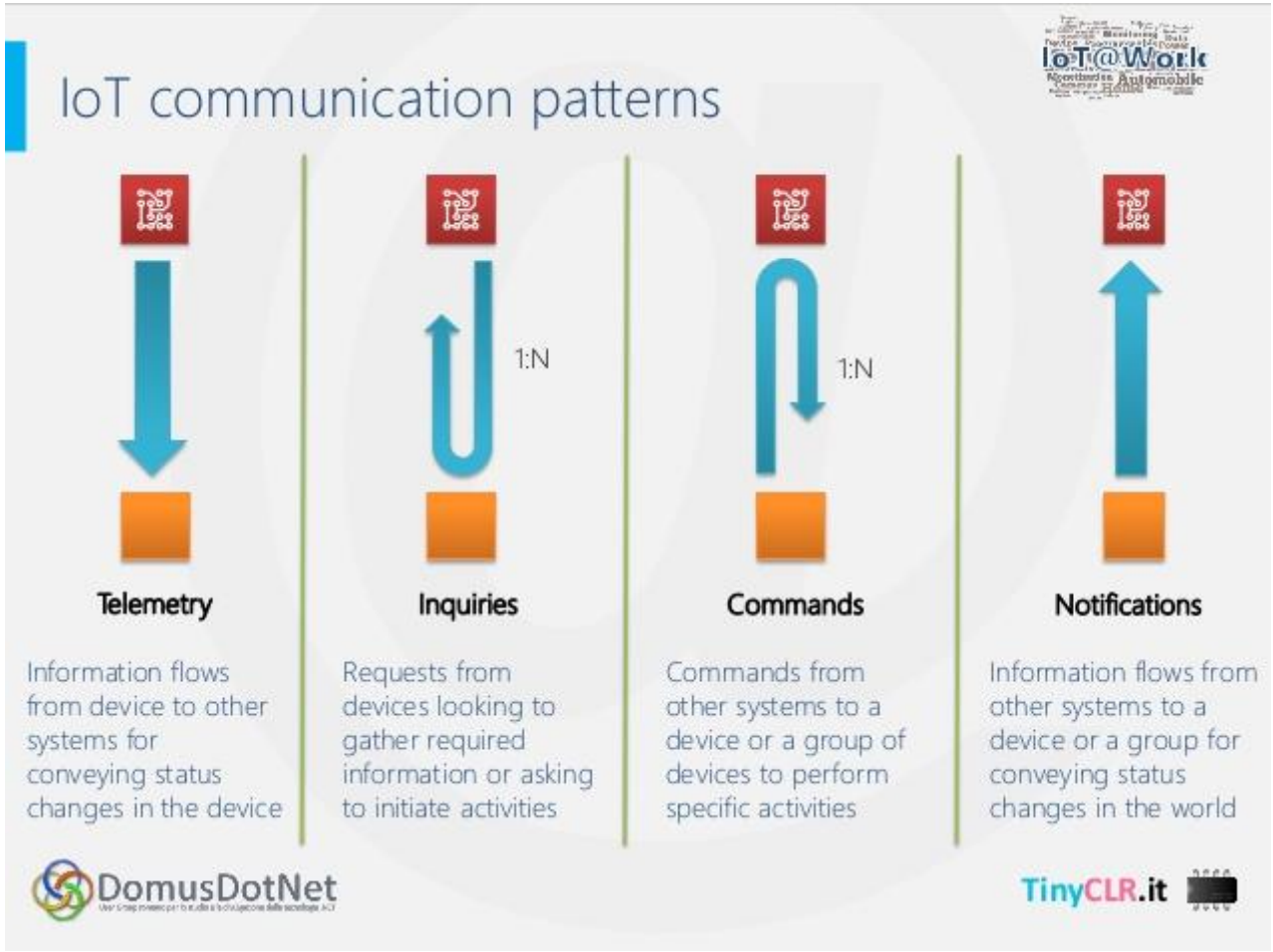
$$I = \Sigma (I_c + I_n + I_t)$$

Key Point to Consider: $I_n > 0$

IoT Backhaul Considerations

- Application
- Business Model
- Data rate required
- Symmetry of the data flow(s)
- Distance
- Power consumption
- Costs
  - Initial and recurring
- End-to-end QoS
  - Availability
  - Latency
  - Jitter
  - Security
  - Location
  - Frequency of communication
    - “Call Setup” time
  - Size of “message”
  - Type of data

Information Flows



Network Options (Short Haul)

	Speeds	Cost (Chip) Estimates	Monthly* Approx. Est.	Range*	Comments
BlueTooth /BTLE	<3 Mbps	<$1	$0	~10 ft	
NFC	~400 Kbps	<$1	$0	~1 ft	
RFID		<$1	$0		
ZigBee (802.15n)	10 to 250k	<$1	$0	10-20 meters	Mesh part of base protocol
Z-Wave	10 to 40 Kbps	<$1	$0	< 30 m (100ft)	
WiFi	Up to 50 Mbps	<$1	$0	<150 ft indoor <300 ft. out	NEST is WiFi
Ant+	20-60 kbps	<$1	$0	30 m LOS	Ultra low power.
Emerging?					
Other?					

Network Options (Long Haul)

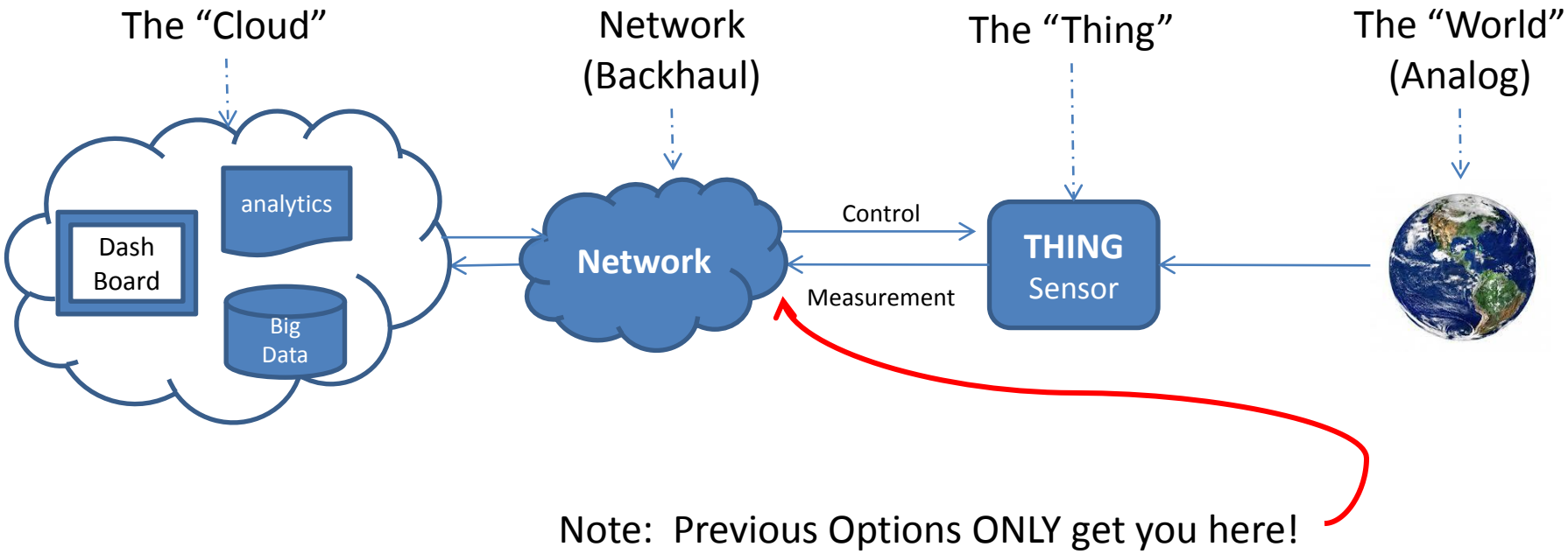
	Speeds	Cost*	Monthly* Approx. Est.	Range*	Comments
Ethernet	Up to 1G	<$1	$0	Depends	
DSL	500Kbps to 5 Mbps	$5 -$25	$10 to $100	100 to 18k ft	
Cable	500 Kbps to 20 Mbps	$5-$20	$10 to $100	Miles	
FTTx	1 to 50 Mbps	?	$30-$1000	Depends	
2G/3G/4G/LTE		$3 to $20	$1 to $100	Miles	
Satellite	1M/256K min		>$40	23,000 miles	
TV White Space					
900 Mhz					
Proprietary					
Other Rural Broadband Options					

Existing Industrial Options

	Speeds	Cost*	Range*	Comments
EtherCat				
DataHighway				
MPI				
CANOpen				
PowerLink				
ModBus				
ProfiBUS				
ProfiNET				
DeviceNET				
Other				

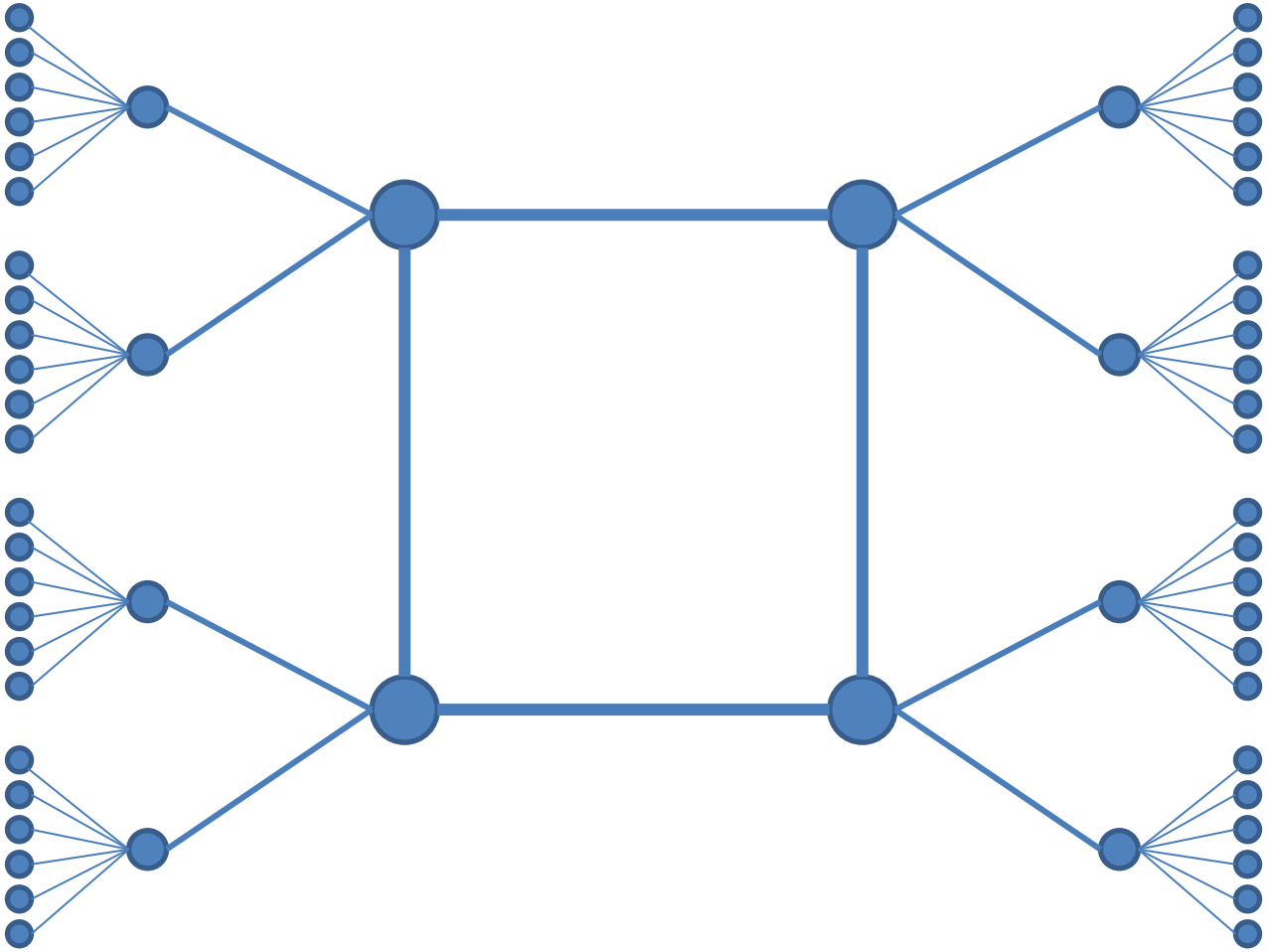
Key Points to Consider:

1. Legacy Proprietary or Niche Standards
2. Migrate to IP for New Apps
3. “Cap & Grow” more likely

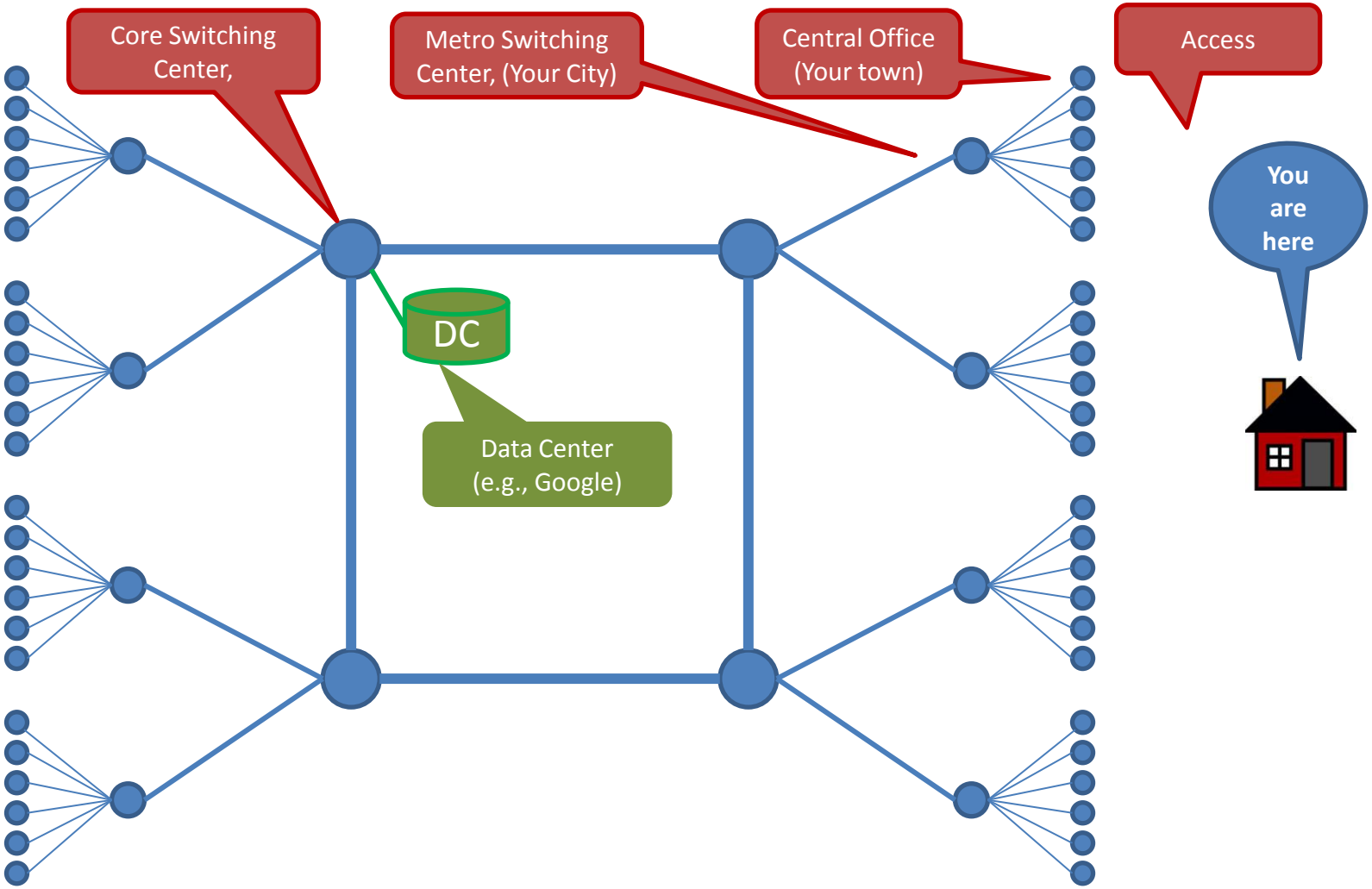

The “Cloud”
Network
(Backhaul)
The “Thing”
The “World”
(Analog)
analytics
Dash
Board
Big
Data
Network
Control
Measurement
THING
Sensor
Note: Previous Options ONLY get you here!

The Network: Wicked Simple View

Greywale Management



The Network: Wicked Simple View

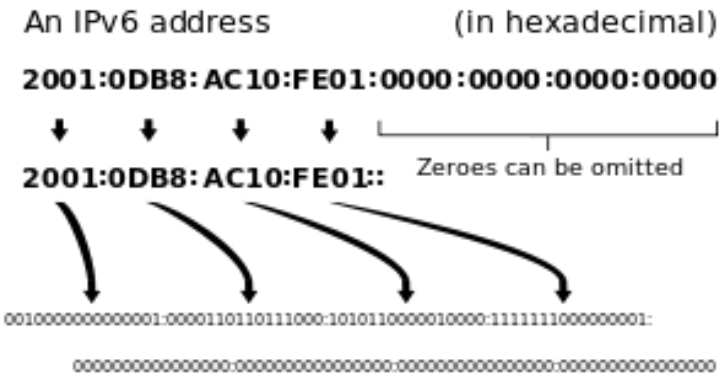


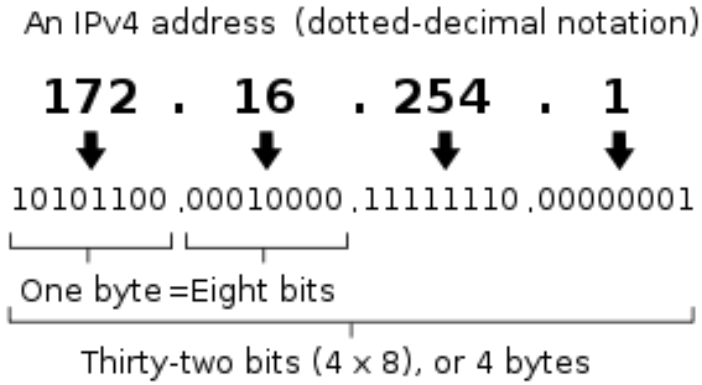
Edge to Core Network

- In many cases will be transparent
  - "Internet Access"
- VPNs are a good candidate for many applications
- CDNs can help in some cases
- Private networks are available but cost are very high

IoT: Drive for IPv6

IPv6 uses a 128-bit address, allowing **2^{128}**, or approximately **3.4×10^{38}** addresses, or more than **7.9×10^{28}** times as many as IPv4, which uses 32-bit addresses and provides approximately 4.3 billion addresses





Higher Layer Protocols

Protocol	CoAP	XMPP	RESTful HTTP	MQTT
Transport	UDP	TCP	TCP	TCP
Messaging	Request/Response	Publish/Subscribe Request/Response	Request/Response	Publish/Subscribe Request/Response
2G, 3G, 4G Suitability (1000s nodes)	Excellent	Excellent	Excellent	Excellent
LLN Suitability (1000s nodes)	Excellent	Fair	Fair	Fair
Compute Resources	10Ks RAM/Flash	10Ks RAM/Flash	10Ks RAM/Flash	10Ks RAM/Flash
Success Storied	Utility Field Area Networks	Remote management of consumer white goods	Smart Energy Profile 2 (premise energy management/home services)	Extending enterprise messaging into IoT applications

Protocol Comparisons

- **CoAP** (Constrained Application Protocol) over UDP is used for resource constrained, low-power sensors and devices connected via lossy networks, especially when there is a high number of sensors and devices within the network. Soon to be released as a suite of IETF RFCs, CoAP has already found success as a key enabling technology for electric utility AMI (advanced metering infrastructure) and DI (distributed intelligence) applications within Cisco's Field Area Network.

- **XMPP** (Extensible Messaging and Presence Protocol) has its roots in instant messaging and is a contender for mass scale management of consumer white goods, such as washers, dryers, refrigerators, and so on. But because it assumes a persistent TCP connection and lacks an efficient binary encoding, it's typically not been practical over LLNs (Low-power and Lossy Networks). But the recent work of XEP-0322, XEP-323, and XEP-324 aim to make XMPP suited for IoT.

- **RESTful HTTP** over TCP is particularly attractive for connecting consumer premise devices, given the near universal availability of HTTP stacks for various platforms. The RESTful HTTP approach has found success in smaller scale LLNs requiring message latencies of several seconds (home energy management, etc.).

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Thank You

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Back Up Slides

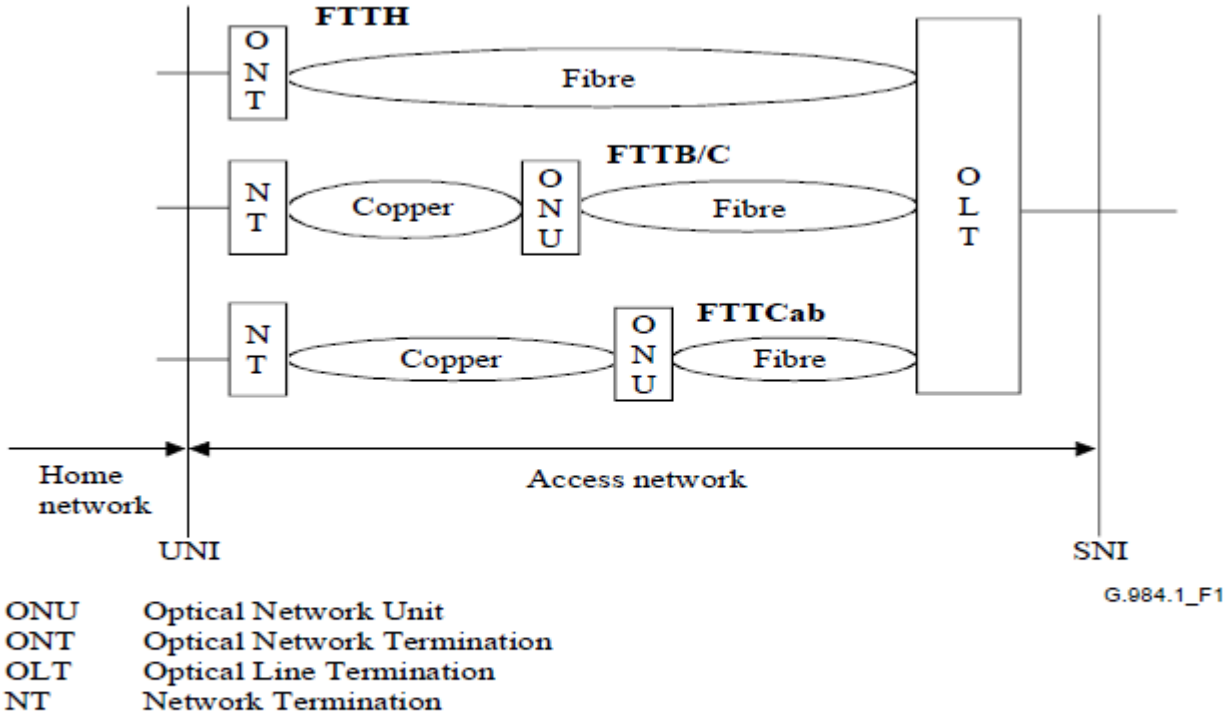
Comparison Example

Aspect	NFC	Bluetooth	Bluetooth Low Energy
RFID compatible	ISO 18000-3	active	active
Standardisation body	ISO/IEC	Bluetooth SIG	Bluetooth SIG
Network Standard	ISO 13157 etc.	IEEE 802.15.1	IEEE 802.15.1
Network Type	Point-to-point	WPAN	WPAN
Cryptography	not with RFID	available	available
Range	< 0.2 m	~100 m (class 1)	~50 m
Frequency	13.56 MHz	2.4–2.5 GHz	2.4–2.5 GHz
Bit rate	424 kbit/s	2.1 Mbit/s	1 Mbit/s
Set-up time	< 0.1 s	< 6 s	< 0.006 s
Power consumption	< 15mA (read)	varies with class	< 15 mA (read and transmit)

xDSL Comparison

Family	ITU	Name	Ratified	Maximum Speed capabilities
ADSL	G.992.1	G.dmt	1999	7 Mbps down 800 kbps up
ADSL2	G.992.3	G.dmt.bis	2002	8 Mb/s down 1 Mbps up
ADSL2plus	G.992.5	ADSL2plus	2003	24 Mbps down 1 Mbps up
ADSL2-RE	G.992.3	Reach Extended	2003	8 Mbps down 1 Mbps up
SHDSL (updated 2003)	G.991.2	G.SHDSL	2003	5.6 Mbps up/down
VDSL	G.993.1	Very-high-data-rate DSL	2004	55 Mbps down 15 Mbps up
VDSL2 -12 MHz long reach	G.993.2	Very-high-data-rate DSL 2	2005	55 Mbps down 30 Mbps up
VDSL2 - 30 MHz Short reach	G.993.2	Very-high-data-rate DSL 2	2005	100 Mbps up/down

FTTx Option



FTTH = Home
FTTP = Pedestal
FTTC = Curb
FTTN = Node

. Rec. G.984.1 Networks Architecture. Source: ITU-T Rec. G.984.1 (2008/03)

ANT+

- ANT+ is primarily designed for the interoperable collection and transfer of sensor data as well as the integration of remote control systems such as indoor lighting, phone control, etc. Several main focuses of operation include sport, wellness, home care and remote control. It can be used for data-transfer for a number of devices:[3][4][5]
  - heart rate monitors
  - speed sensors
  - cadence sensors
  - foot pods
  - power meters
  - activity monitors
  - calorimeters
  - body mass index measuring devices
  - blood pressure monitors
  - blood glucose meters
  - pulse oximeters
  - position tracking
  - short range homing beacons (Disc Golf, GeoCaching)[6]
  - weight measuring devices
  - control of music players
  - control of lighting
  - temperature sensors
  - light electric
  - vehicle monitoring
  - fitness equipment
  - tire pressure monitor systems (TPMS)
  - This allows for it to be used for general fitness tasks, medical and remote control functions. Currently ANT+ is implemented on more than 35 applications, produced by over 27 different manufacturers.[7]

Protocol Notes

Choose MQTT If…

- Think of it as collection?
- Little device-device communications?
- Large number of devices?
- Very small devices?

• 3 or 4 => MQTT

Understanding the IoT Protocols

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Choose AMQP If…

- Distributing work, not information?
- Just send A to B?
- Speed & CPU use not important?
- Can't lose anything?

• 3 or 4 => AMQP

Understanding the IoT Protocols

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Choose XMPP/REST If…

- Use the word "my"?
- Few connectivity points in large space?
- Speed & CPU use not important?
- "Always" connected?

• 3 or 4 => XMPP or REST

Understanding the IoT Protocols

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Choose DDS If…

- Disaster if offline for 5 minutes?
- Measure performance in ms or us? Or scale >100+ applications? Or 10k+ data values?
- Code actively developed for >3 yrs?

• 2 or 3 => DDS

Understanding the IoT Protocols

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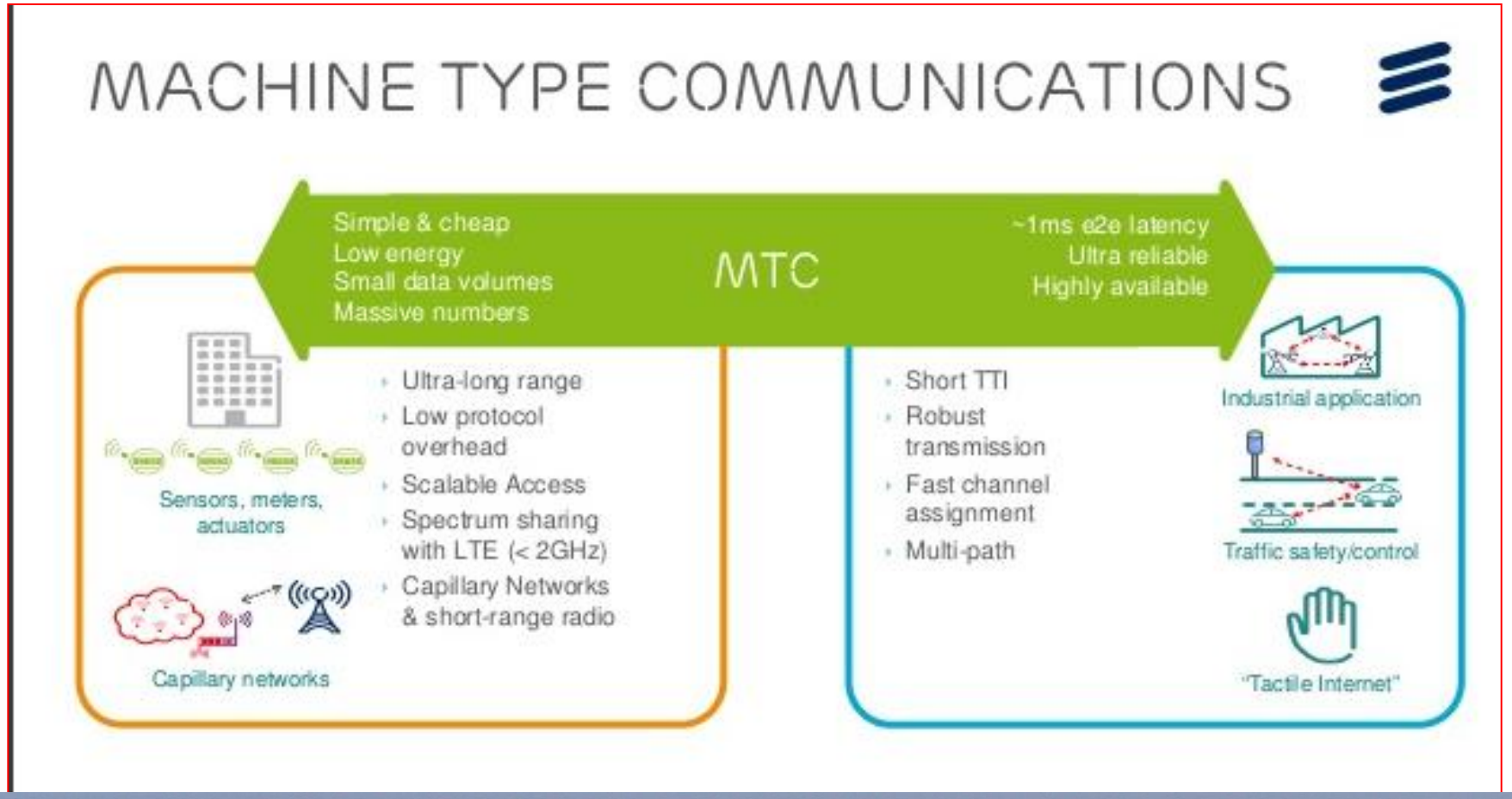
Range of IoT Applications



Open Interconnect Consortium

- We are defining the specification, certification & branding to deliver reliable interoperability — a connectivity framework that abstracts complexity
- This standard will be an open specification that anyone can implement and is easy for developers to use
- It will include IP protection & branding for certified devices (via compliance testing) and service-level interoperability
- There will also be an Open Source implementation of the standard
- This Open Source implementation will be designed to enable application developers and device manufacturers to deliver interoperable products across Android, iOS, Windows, Linux, Tizen, and more.