Illinois Tech Real Time Communications Conference October 13-15, 2020

IBM Watson

Cognitive Telescope Network: Internet of Telescopes

Development of a Passively Safe Network of Small Telescopes Connected using IBM Internet of Things Protocols

October 13, 2020

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ILLINOIS INSTITUTE OF TECHNOLOGY

Center for Advanced Studies

IBM

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Dr. Jeff Terry is a professor of physics at the Illinois Institute of Technology, where his main research focus is on energy systems. His group works to develop new ways to deal with radioactive waste; to understand radiation damage mechanisms in materials; and to synthesize novel materials for energy storage and conversion. He also simulates the economic costs of building new energy systems, including small modular nuclear reactors. Prior to joining the faculty at Illinois Tech, he was a staff scientist at Los Alamos National Laboratory. There, he worked on the Stockpile Stewardship and Management Program and the Waste Isolation Pilot Plant (WIPP) and was a member of the team that sent the first waste shipment to WIPP. He currently writes a regular column for the Bulletin of the Atomic Scientists. He is a former scientific director of the Advanced Test Reactor National Scientific User Facility. Terry received his doctorate in chemical physics from Stanford University in 1997 after obtaining a bachelor's degree in chemistry from the University of Chicago in 1990.

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Arunava (Ron) Majumdar is a Watson and Cloud architect with over 20 years of experience in Software design and development. He leads the Asset Portfolio Strategy for the IBM Watson and Cloud Platform and is the lead for the Chicago Center for Advanced Studies. He has been involved with large scale design, architecture and implementation for IBM clients, helping them successfully through the project lifecycle. He has architected High Availability and Disaster Recovery solutions with IBM integration products and worked on performance testing and securing client environments.

Ron started as a software engineer working with Object Oriented Programing languages, Middleware integration technologies and Relational Databases. He is currently working on Watson services, Internet-of-Things, Micro-services, API Economy, Hybrid Integration and Pattern-based automation. He is deeply involved with moving workloads to the cloud and Application Modernization. Ron has several patents and published assets to his credit and is collaborating with Research faculty and Universities on innovative ideas and their implementations with emerging technologies. He is also leading several efforts for a comprehensive innovation strategy for IBM in the Greater Chicago area.

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Rahul Gupta, STSM, is a Senior Software Engineer with IBM Watson Internet of Things Business Unit. He is a Certified Service Oriented Architecture (SOA) Architect with twelve years of professional experience in IBM messaging technologies. In his current role, he works as technical lead and Architect in the Watson Internet of Things Platform Development and Blockchain. Rahul is also a Senior Member of the IBM Academy of Technology.

- **Evolution of the telescope network**
  - Multi-messenger Astronomy
  - Architecture of the network
  - Event monitoring and follow-up
- **Safely connecting telescopes to the network**
  - Remote Observatory
  - Protecting the telescope
  - INDIGO server and astrometry
- **Controlling telescopes from the Cloud**
  - IBM Watson IoT Platform overview
  - MQTT Protocol for device communication
  - Design for connected telescopes

"Only those who will risk going too far can possibly find out how far one can go." — T.S. Eliot

Cognitive Telescope Network:

Evolution of Thought

Brainstorming and developing Use Cases through Design Thinking

Ever since the dawn of time human beings are trying to decipher the mysteries of the Universe by looking at the Sky.

~200 BC – **Hipparchus** creates a magnitude system (1-6) and catalogs 850 stars

1610 – **Galileo Galilei** publishes Sidereus Nuncius from his observations from the telescope

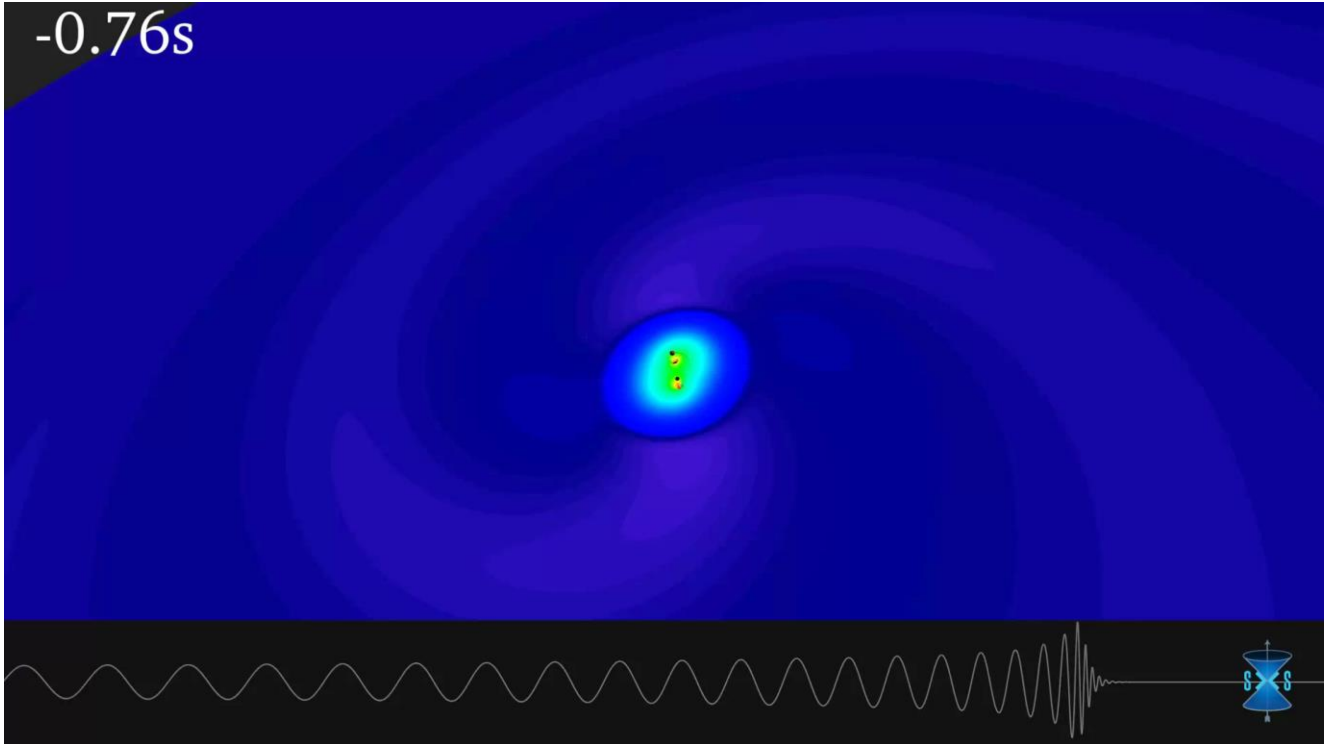
1668 – **Isaac Newton** builds reflecting telescope

1990 – **Hubble Space Telescope** is launched by NASA

2009 – Largest Telescope on Earth commissioned **Gran Telescopio Canarias**, Canary Islands, Spain beating Keck 1 and Keck 2, Mauna Kea Observatory, Hawaii

2012 – Construction of **Giant Magellan Telescope** will be located at Cerro Las Campanas at Las Campanas Observatory in the Atacama Desert of Chile

2018 – **James Webb Space Telescope** expected to be launched



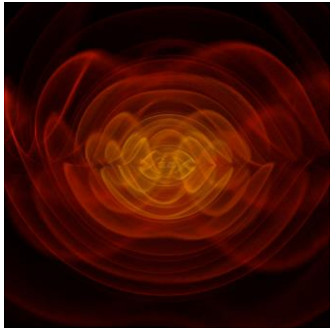
Courtesy: Simulating eXtreme Spacetime (SXS) Project: www.black-holes.org

Since the prediction by Einstein scientists have been trying to detect Gravitational Waves.

- Detect not with light, but with gravity.
- Gravitational waves are complementary to photons
    - Photons are made by atoms
    - Gravitational waves made by the dynamic motion of matter
- Laser Interferometers, not telescopes are required for the detection
- **LIGO** – US-based detectors at *Livingston*, Louisiana, and *Hanford*, Washington
- **VIRGO** – Italy-France-based initiative at Santo Stefano a Macerata, Cascina , Italy
- **LISA** – 1st Space-based Interferometer using 3 satellites, European collaboration

Gravitational Wave Detectors

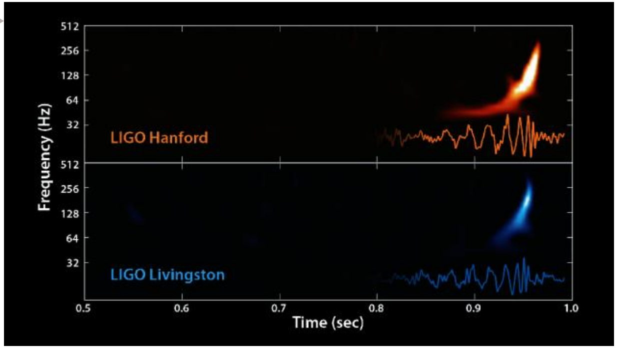
GW150914



29 solar mass black hole +
36 solar mass black hole
1.3 billion lightyears away
(400 Mega parsec)

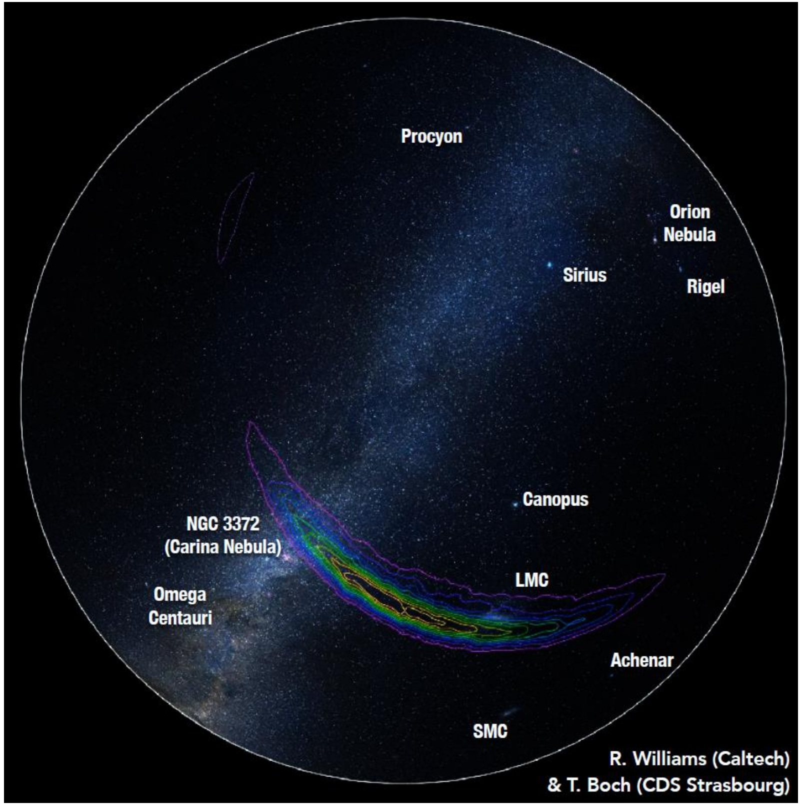
- (1995) TAMA 300 - Japan - Decommissioned
- (1995) GEO 600 - Sarstedt, Ruthe, Germany: http://www.geo600.org/
- (2002) **LIGO** - Livingston, Louisiana and Hanford, Washington, USA: http://www.ligo.org/
- (2003) MiniGrail - Leiden University, Netherlands: http://www.minigrail.nl/
- (2005) Pulsar Timing Array (using radio-telescope): https://en.wikipedia.org/wiki/Pulsar_timing_array
  - Parkes PTA, European PTA, North American Nanohertz Observatory for Gravitational Waves (NANOGrav)
- (2006) CLIO - prototype for KAGRA
- (2007) **Virgo** - Santo Stefano a Macerata, Cascina , Italy: https://www.ego-gw.it/
- (2015) LISA Pathfinder, a development mission for LISA, launched in Dec. - switched off 18 July, 2017
- (2018) KAGRA - Gifu Prefecture, Japan: http://gwcenter.icrr.u-tokyo.ac.jp/en/
- (2023) IndIGO - (Hingoli, Maharashtra?), India: http://www.gw-indigo.org/tiki-index.php
- (2025) TianQin - Sun Yat-sen University, Zhuhai campus, China [Space-based]
- (2027) DECIGO - Japan [Space-based]
- (2034) **LISA** - Denmark, France, Germany, Italy, The Netherlands, Spain, Switzerland and the UK
  – supported US, [Space-based]: https://www.lisamission.org/
- (2030s) Einstein Telescope - European Union: http://www.et-gw.eu/

C. Messenger (Glasgow) & LIGO

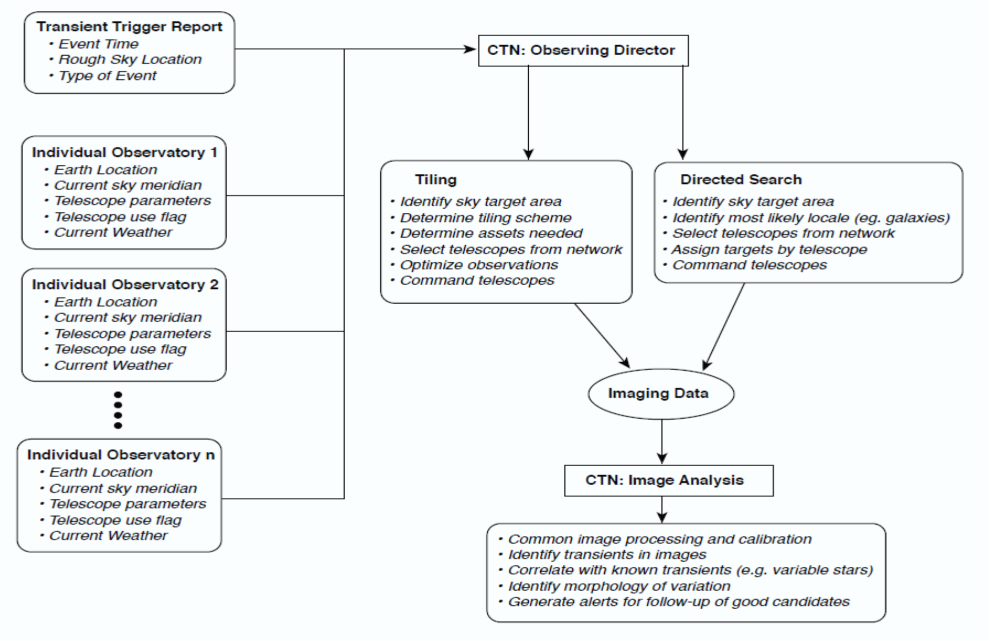


IBM Watson Cognitive Telescopic Network

Multi-messenger Astronomy



Predicted area for the detection of the event GW150914



Courtesy: Dr. Shane Larson, Research Associate Professor, Associate Director of CIERA, Northwestern University

IBM Watson Brainstorming: **Defining the problem**

Works successfully

- Local Telescope Networks exist
- Large telescope produce data for scientific research
- Time scheduling on telescopes for observations by the Observing Director
- Some pictures are made available to the public after manually processing them
- Results are published in scientific journals
- Events are published on websites and popular magazines and few mobile apps

Challenges

- There is no large scale telescope network
- No telescope network can be triggered by trasient events
- Large telescopes cannot be accessed when a trasient occurs
- No common interface to subscribe to events or pictures
- No community where telescope time can be shared on a grid
- Amateur astronomer contributions are not coordinated centrally

Improvements

- Autonomous Scheduling for Tiling of Directed Search
- Increase network of telescopes using a common protocol and control center
- Publishing raw images from telescopes for further analysis
- Location based subscription of events based on interest
- Interactive chatbot with domain knowledge in multiple languages

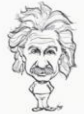
Innovation

- Visual Recognition to classify astronomical objects
- Using Machine Learning to understand telescopes for improved tiling
- Using Cognitive pointing technology to understand data
- Understanding mapping and triggering of telescope network
- Capturing Social and Scientific data to communicate to the general audience
- Virtual Reality simulations for a better UX and understanding of cosmology

Deployment

- Hybrid deployment with on-premise telescopes and devices
- Building a corpus of Astronomical data
- Watson services on the IBM Cloud
- IoT services on the IBM Cloud

Personas

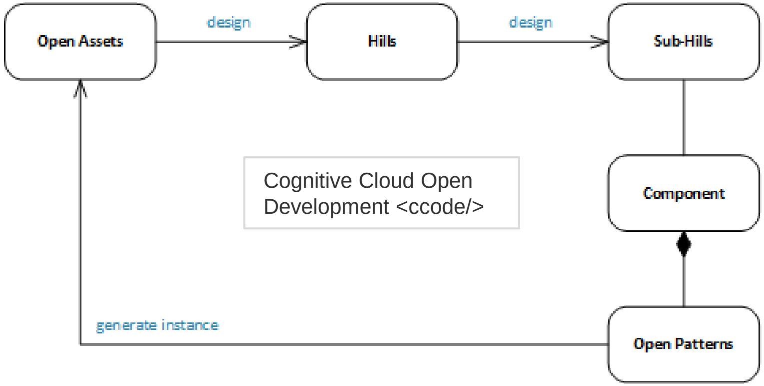


The Scientific Community	Observing transients for followup research using larger telescopes

The Amateur Observer	Sharing and reporting observations, sharing telescope time

The Science Enthusiast	Picture and information about astronomy, interactive chatbot

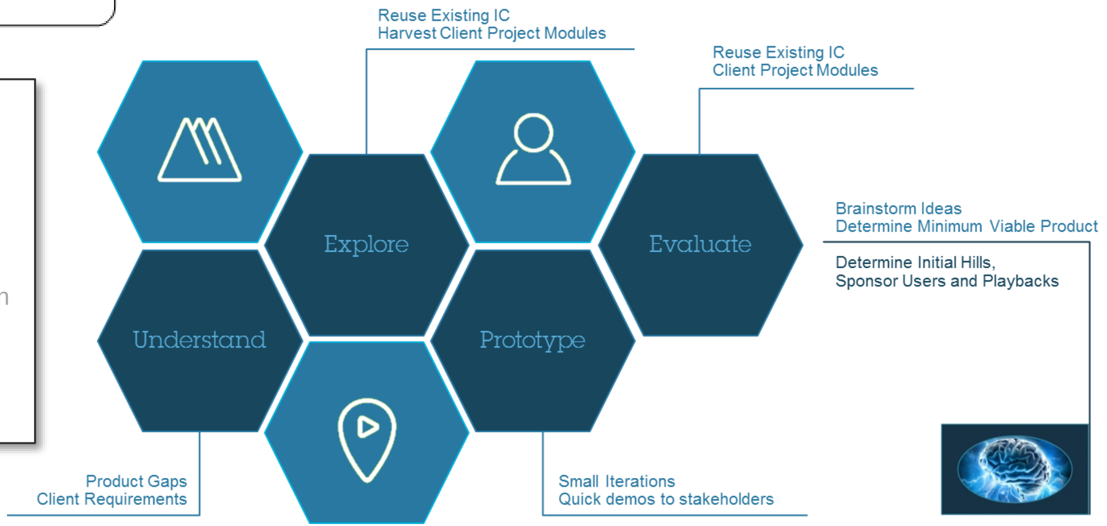
M https://app.mural.co/



Evolving Assets using Design Thinking:

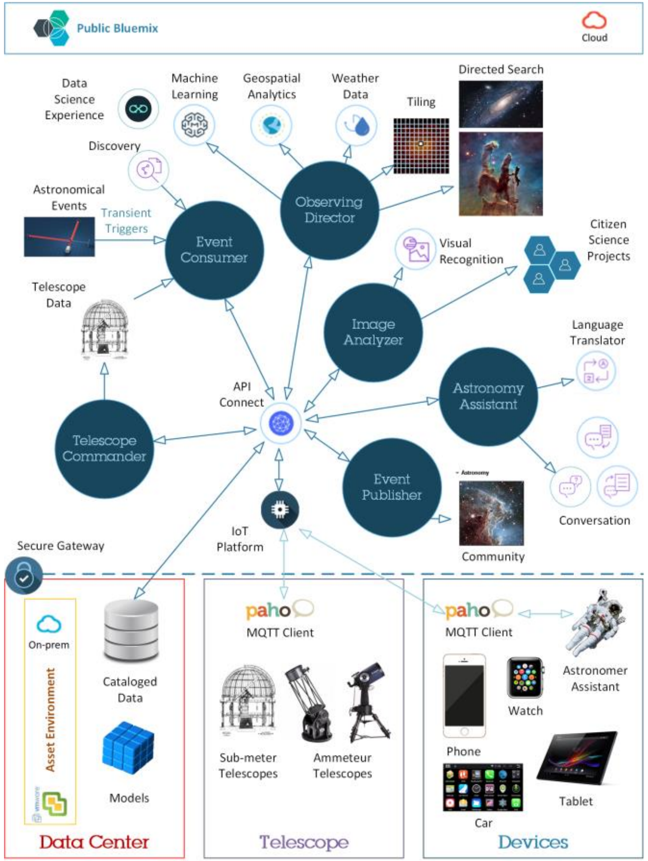
- Open Assets
  - ✓ Work with end users and researchers to define use cases
  - ✓ Organize thoughts under 3 Hills and Foundation
  - ✓ Define Sponsor Users for getting feedback from playbacks and continuous improvement of the design
  - ✓ Define Components / features
  - ✓ Define Open Projects, Timelines, Iterations, Playbacks, Milestones

- Open Patterns
  - ✓ Identify common patterns within the code and documentation from multiple assets
  - ✓ Patterns may be identified and developed by the Offering Management and other teams to accelerate Open Project development
  - ✓ Exemplars are patternized into templates that can generate code, document, etc. for Open Assets



IBM Watson Cognitive Telescopic Network

Join us: http://ibm.biz/asset-ctn



Gravitational Waves Detected 100 Years After Einstein's Prediction –

LIGO Opens New Window on the Universe with Observation of Gravitational Waves from Colliding Black Holes.

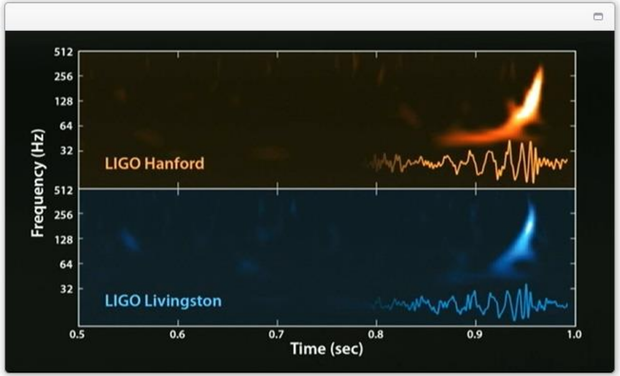
https://www.ligo.caltech.edu/news/ligo20160211

LIGO can listen to gravitational waves but cannot see the event.

- Provide identification and analysis of astronomical data from multiple sources
- Event notifications to mobile devices for building interest in the Community
- Remote control instructions to telescopes point to the specific location on the grid in the sky
- Visual Recognition integration with Zooniverse for gamification of un identified events

- LIGO data feed is parsed into canonical models and passed to the Event Analyzer
- If a Gravitational Wave event is detected, the available telescopes in the network are mapped into a grid to scan the sky
- Weather and Geospatial information is used to determine optimal coverage of the viewing area

LIGO Update on the Search for Gravitational Waves

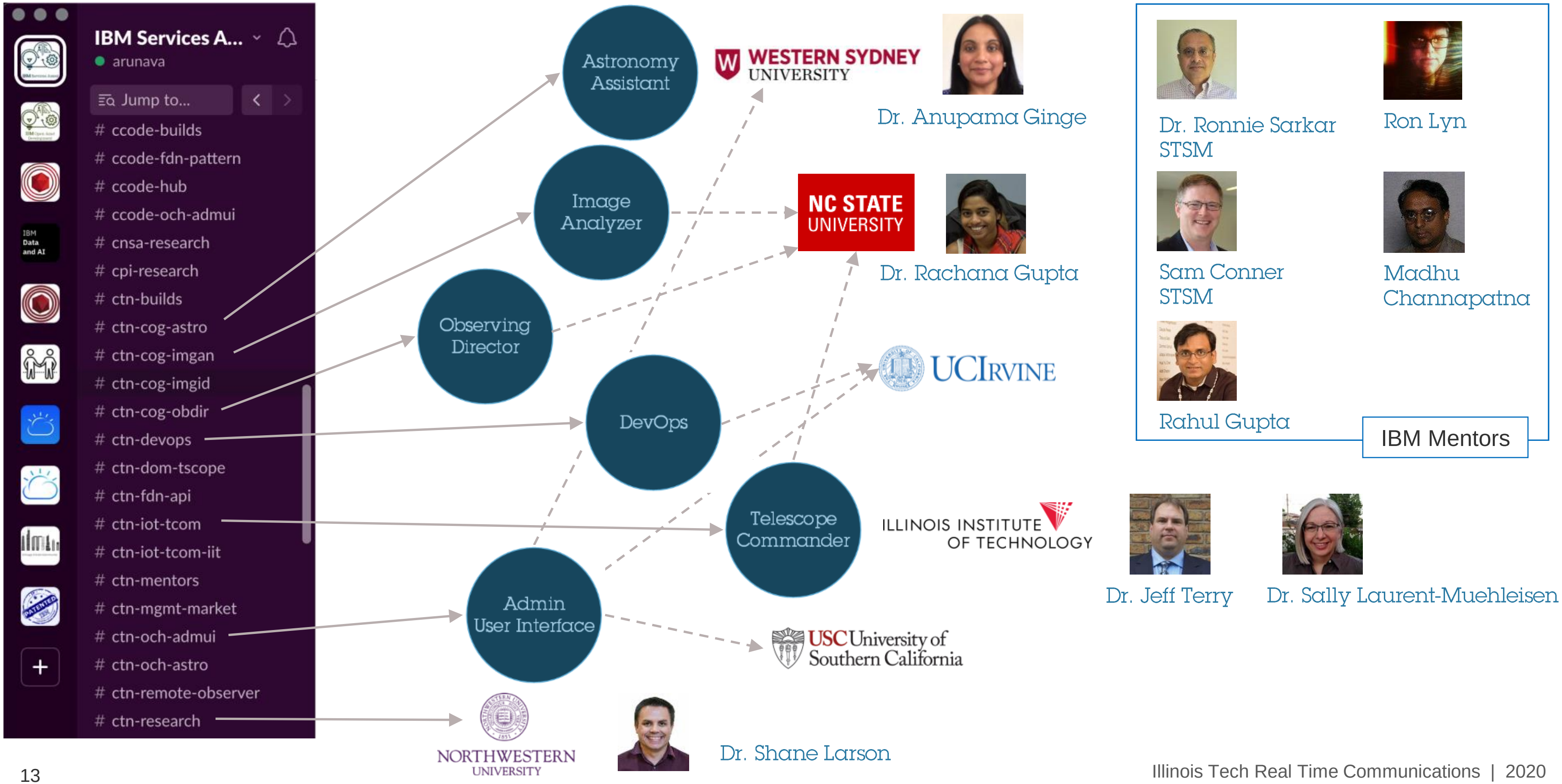


Universities in the collaboration

Northwestern University
Illinois Institute of Technology
Western Sydney University
NC State University
USC University of Southern California
UC Irvine

Using multi-messenger astronomy we have eyes and ears on the transient phenomena in the Cosmos

IBM Watson Cognitive Telescopic Network



Transient Event Sources

Gravitational Waves	**Gravitational-Wave Candidate Event Database (GraceDB)** https://gracedb.ligo.org/latest/
Supernova	**SuperNova Early Warning System (SNEWS)** https://snews.bnl.gov/
Gama Ray Bursts	**Gama Ray Burst Host Studies (GHostS)** http://www.grbhosts.org/Ws.aspx
Variable Stars	**American Association of Variable Star Observers (AAVSO)** https://www.aavso.org/vstar
Fast Radio Burst	**Fast Radio Burst Catalogue (FRBCat)** http://frbcat.org/
Sky Survey	**Make Alerts Really Simple (MARS)** https://mars.lco.global/
	Zwicky Transient Facility (ZTF) https://www.ztf.caltech.edu/

Cognitive Telescope Network:

Safely connecting telescopes

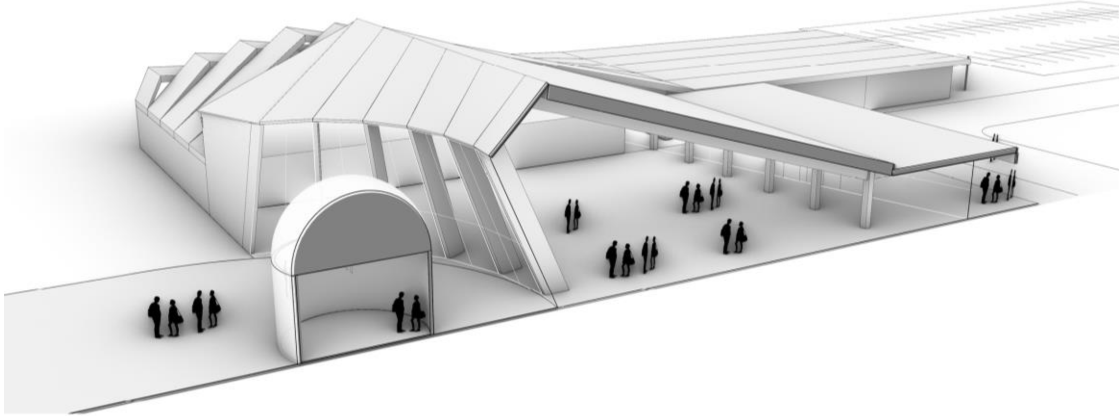
Telescopes, protecting the devices and astrometry

IBM Watson Cognitive Telescopic Network

Remote Observatory

In 2016, an Illinois Tech alumnus, John Buckley, approached us to design a remote astronomy camp for STEM Education. This began our studies in computer assisted remote astronomy.

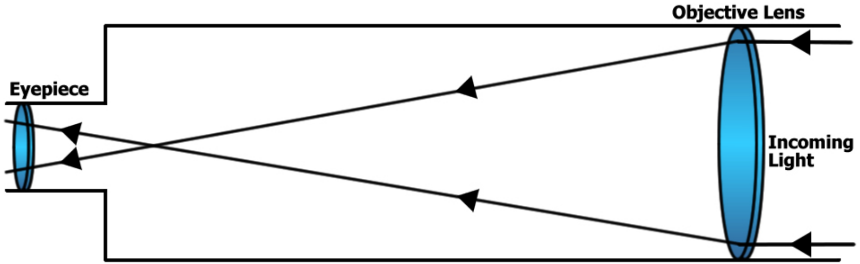
Proposed design for the observatory



- For this site to be useful for University students, it required remote control of the telescope
- Concurrent, with the design work on the remote observatory, we undertook an effort to start designing remote telescope software that could be utilized to #SAFELY control a remote telescope
- In 2018, the IBM Chicago team notified us of an effort to design a network of remote telescopes called the Cognitive Telescope Network controlled by IBM Watson technology.

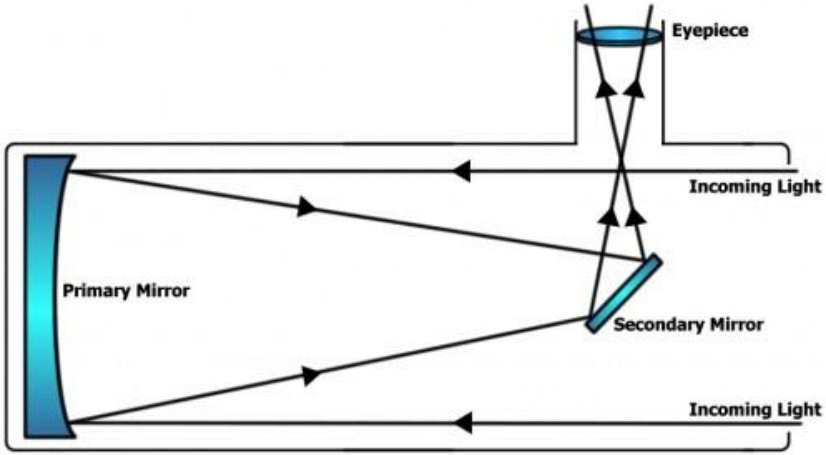
Refractor Telescope

- Typically not very large
- Little maintenance
- Best used for rentals and educational groups

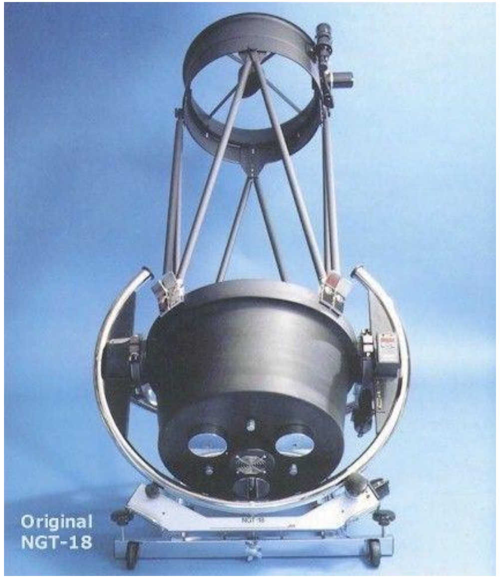


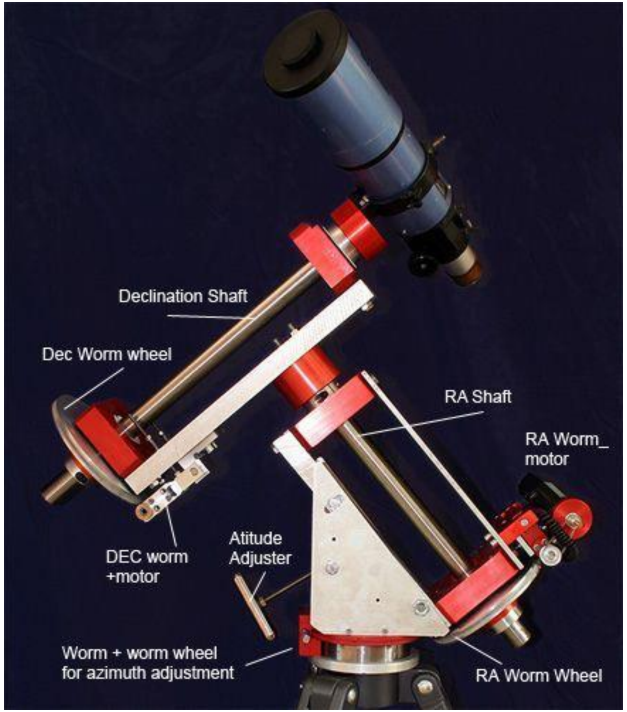
Reflector Telescope

- Can be produced at larger sizes
- Require more maintenance that refractor
- Best for permanent pieces and imaging



- Telescopes are of different shapes and sizes
- They are all fragile and expensive
- Without exception, they will allow you **to destroy themselves**





DESIGN

- Telescope has to take input from IBM Watson
- Determine if the telescope can safely observe
- Safely move telescope to the object
- Safely observe the object
- Report the results back to Watson
- Move the telescope to a safe storage location
- Shutdown the telescope

- It must do this every time
- It must do this for every telescope
- It cannot fail

OBJECTIVES

Ensure safe movement of the telescope by avoiding objects

- Recognizing where the no-go areas of the telescope are
- Implementing safe path-finding algorithms for the telescope to follow

PLAN

- Establish possible range of motion of the telescope
- Map out no-go zones for the telescope
- Develop an initial calibration setup on site
- Establish way of interpreting and storing the boundaries
- Convert the Matlab path-finding algorithm into Python

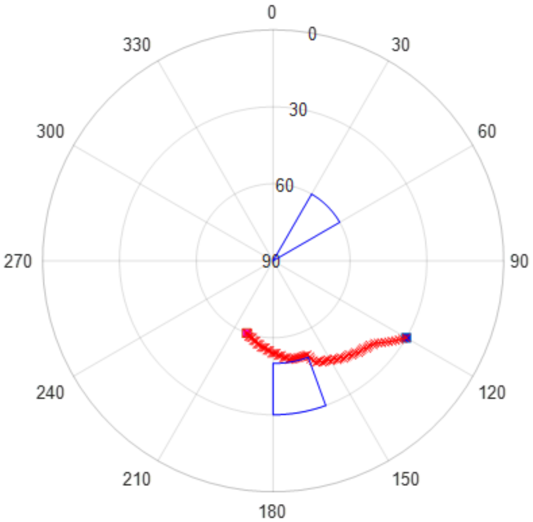


Figure (1): *Implementation of the algorithm using Matlab. The blue closed polygons are the no go areas while the red line is the path.*

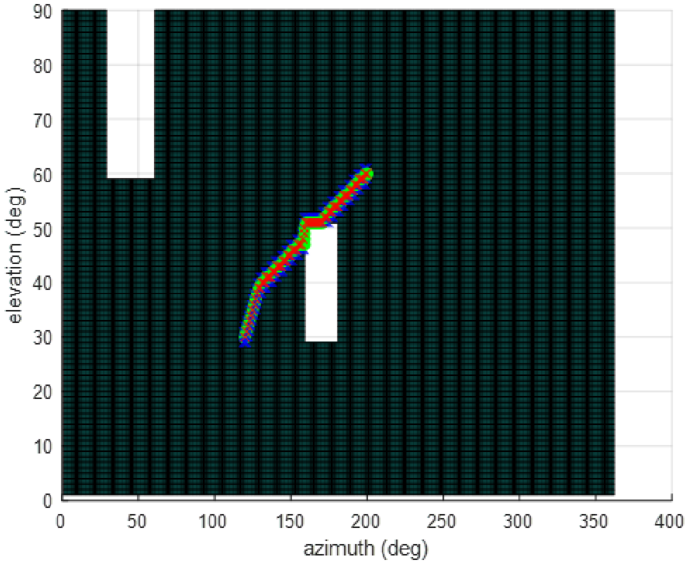


Figure (2): *Implementation of the algorithm using Matlab. The white shapes are the no go areas while the red line is the path.*

DESIGN

- Developed procedure for mapping the no-go zones of the telescope
- Developed path-finding algorithm (A* algorithm) that reads boundaries from *txt files, plots them, and finds the best path

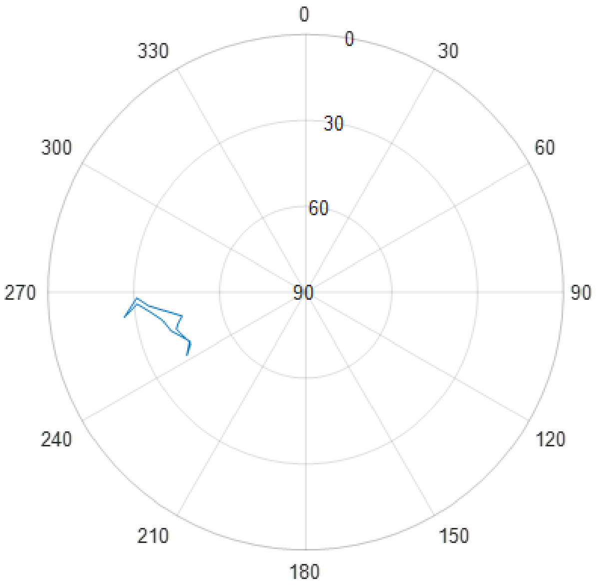
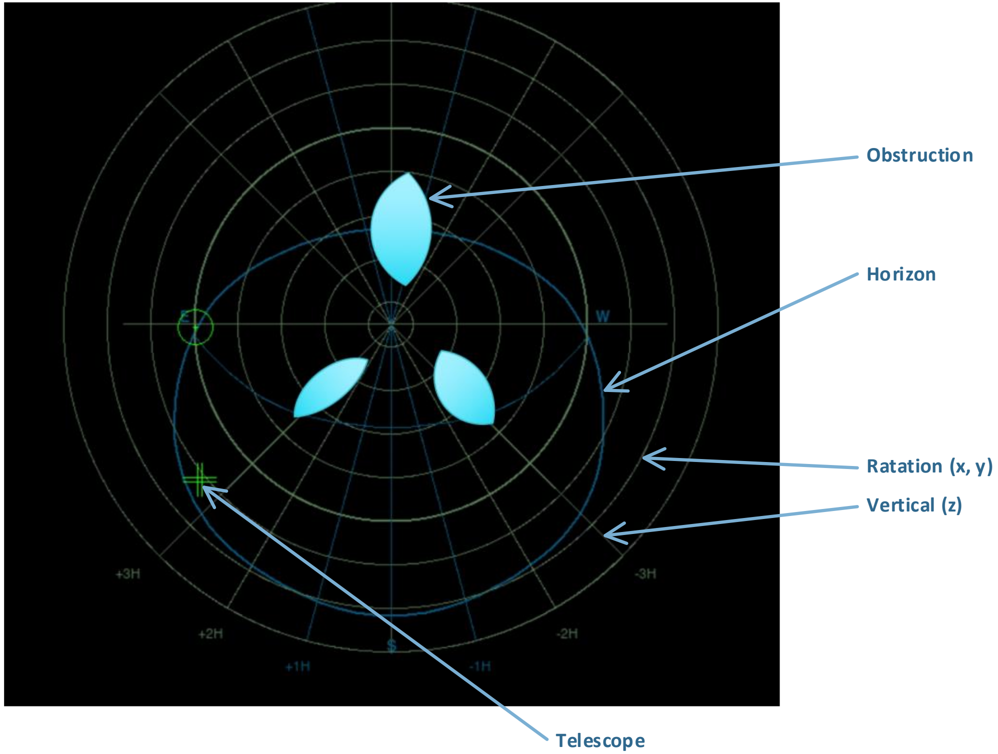
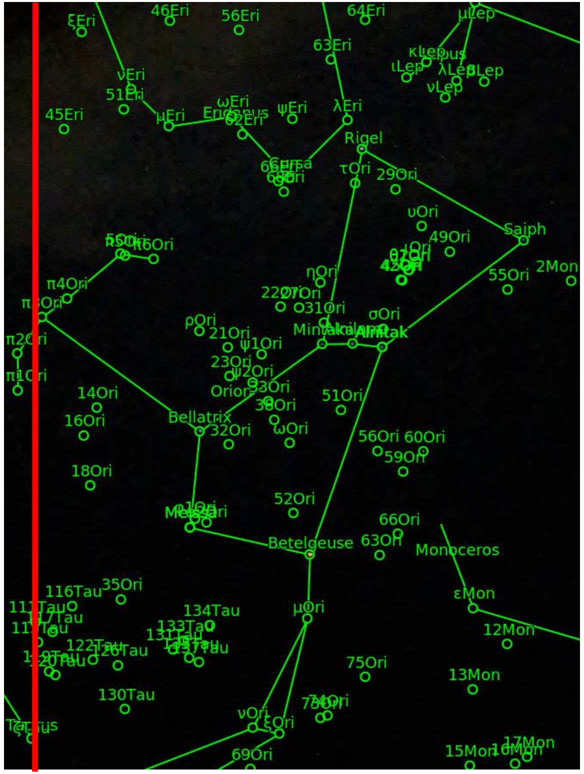


Figure (3): *A danger zone mapped out by the telescope*

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Meissa
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Monoceros
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εMon
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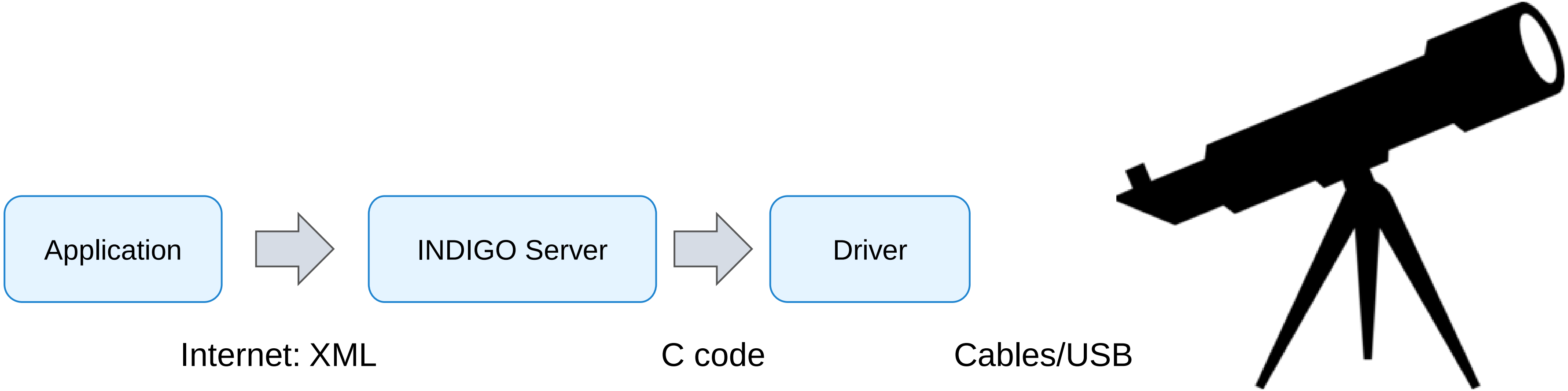
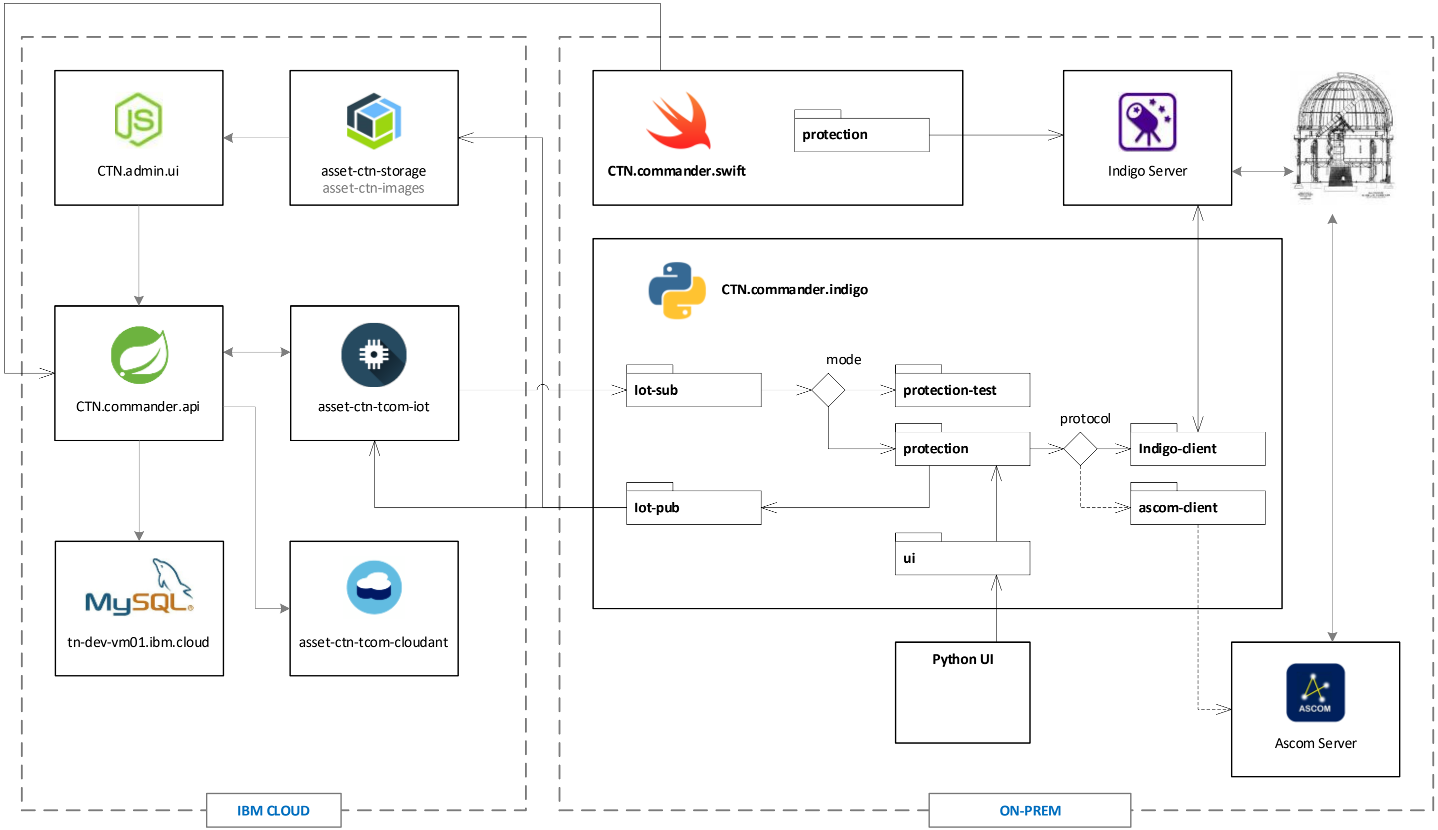
ξOri
69Ori

- Evolved from INDI
- Shared protocol to control any telescope
- Uses XML and JSON commands
- Server takes commands and passes along to telescope
- Server has open Telnet port for external tools to communicate





CTN.admin.ui
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ASCOM
Ascom Server
IBM CLOUD
ON-PREM

IBM Watson Integration with the IIT Telescope

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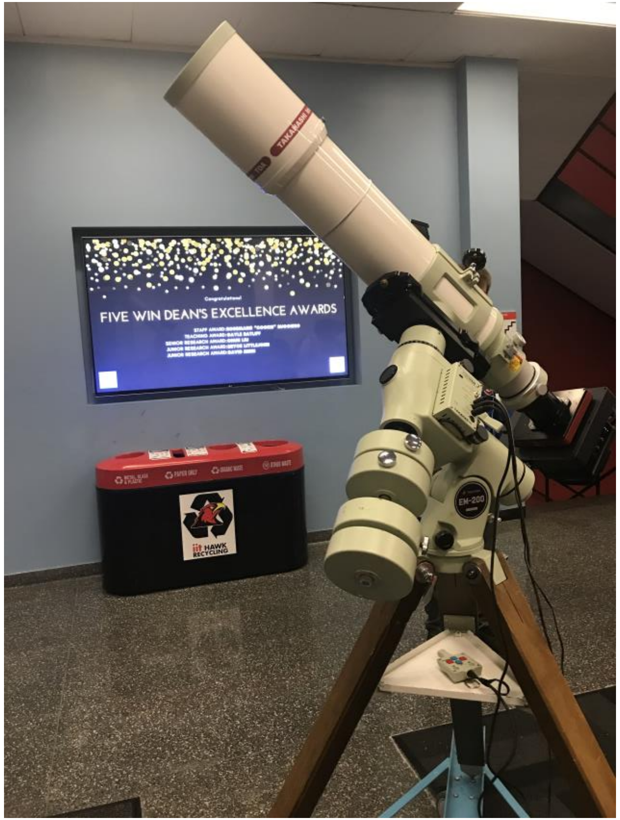
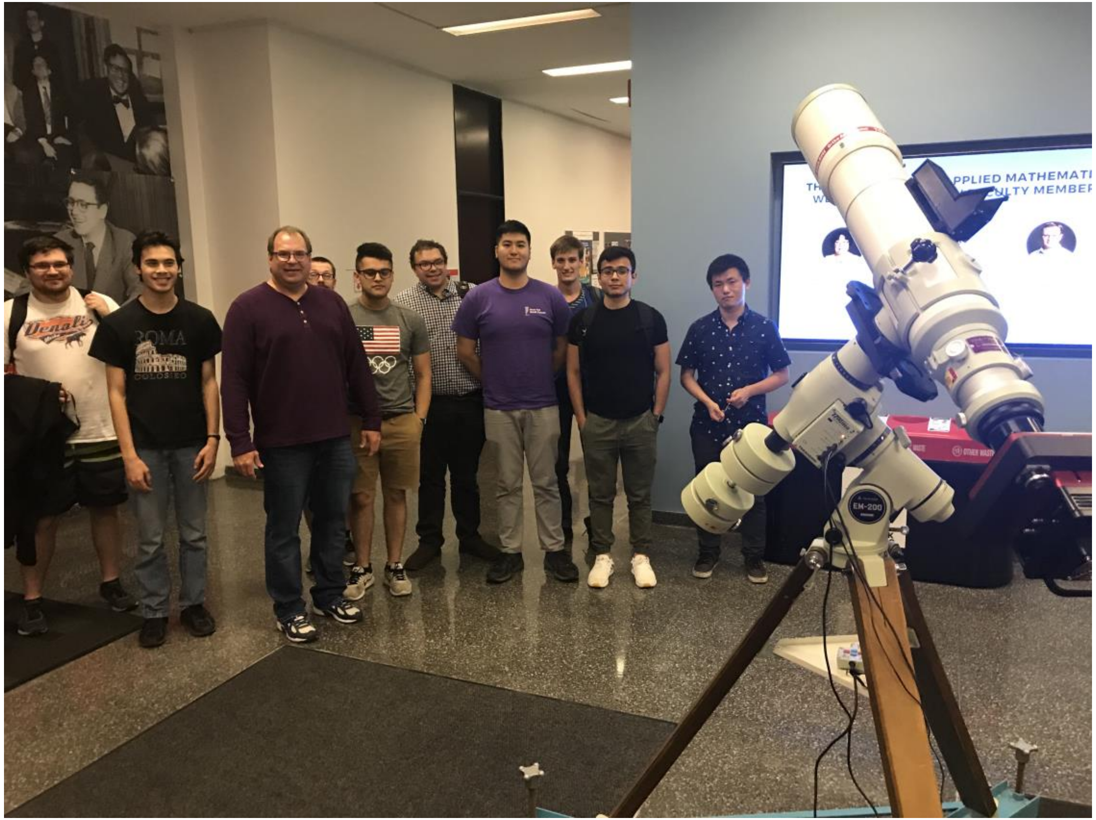
INTER-PROFESSIONAL PROJECTS PROGRAM





https://ipro.iit.edu/

Cognitive Telescope Network:

Controlling telescopes

Watson Internet-of-Things Platform, MQTT Protocol and telescopes


Watson IoT Platform

Watson IoT Platform is a foundation for IBM industry solutions and IoT business use cases

IoT Industry Solutions

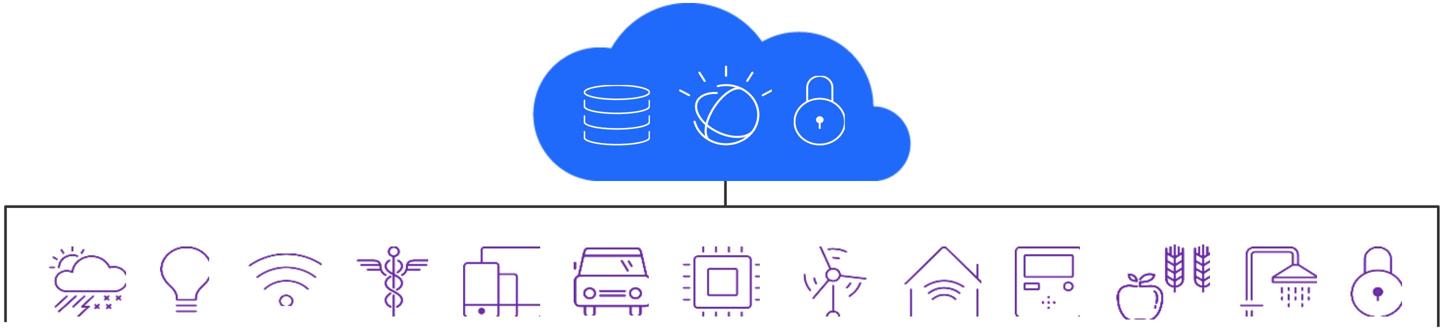
- Enterprise Asset Management
- Production Quality Insights
- Worker Insights
- Facilities Optimization
- Building Insights
- Facilities Management
- Asset Performance Management
- Production Optimization
- Inventory Optimization
- Watson Assistant Solutions
- Continuous Engineering

Watson IoT Platform
Integrated managed service with SLAs and unified per device pricing

Connection Service
Securely connect and store

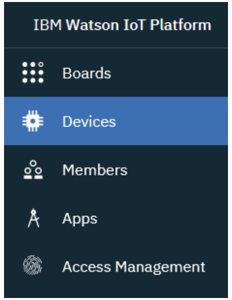
Analytics Service
Explore AI-driven insights

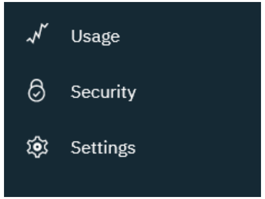
Blockchain Service
Govern and deliver



Flexible device and system management for your IoT devices and applications

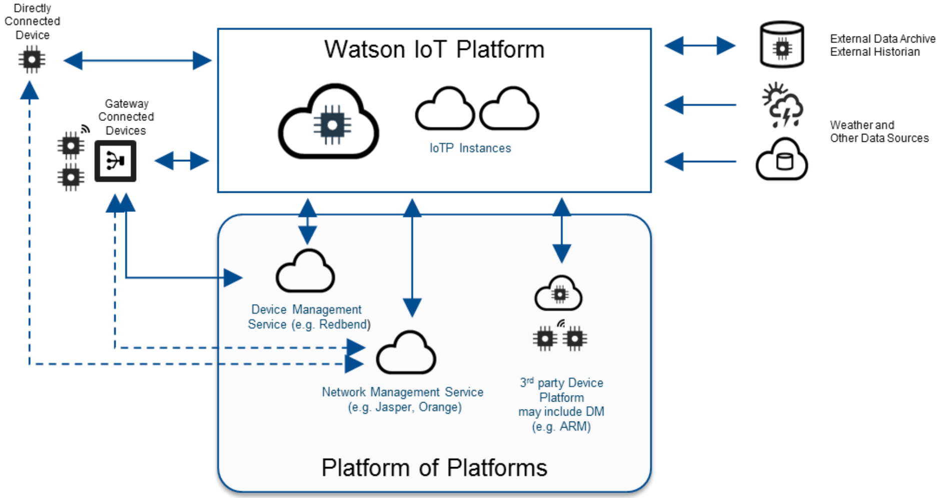
- Device Management
- Flexible device management console provides a preconfigured means to send events such as device reboot, factory reset, or custom device functions such firmware management and upgrades.
- Gateway Management
- Extra functionality and control with gateways as first class type, enabling single connection actions, automatic registrations, and device management on attached devices as separately addressable entities



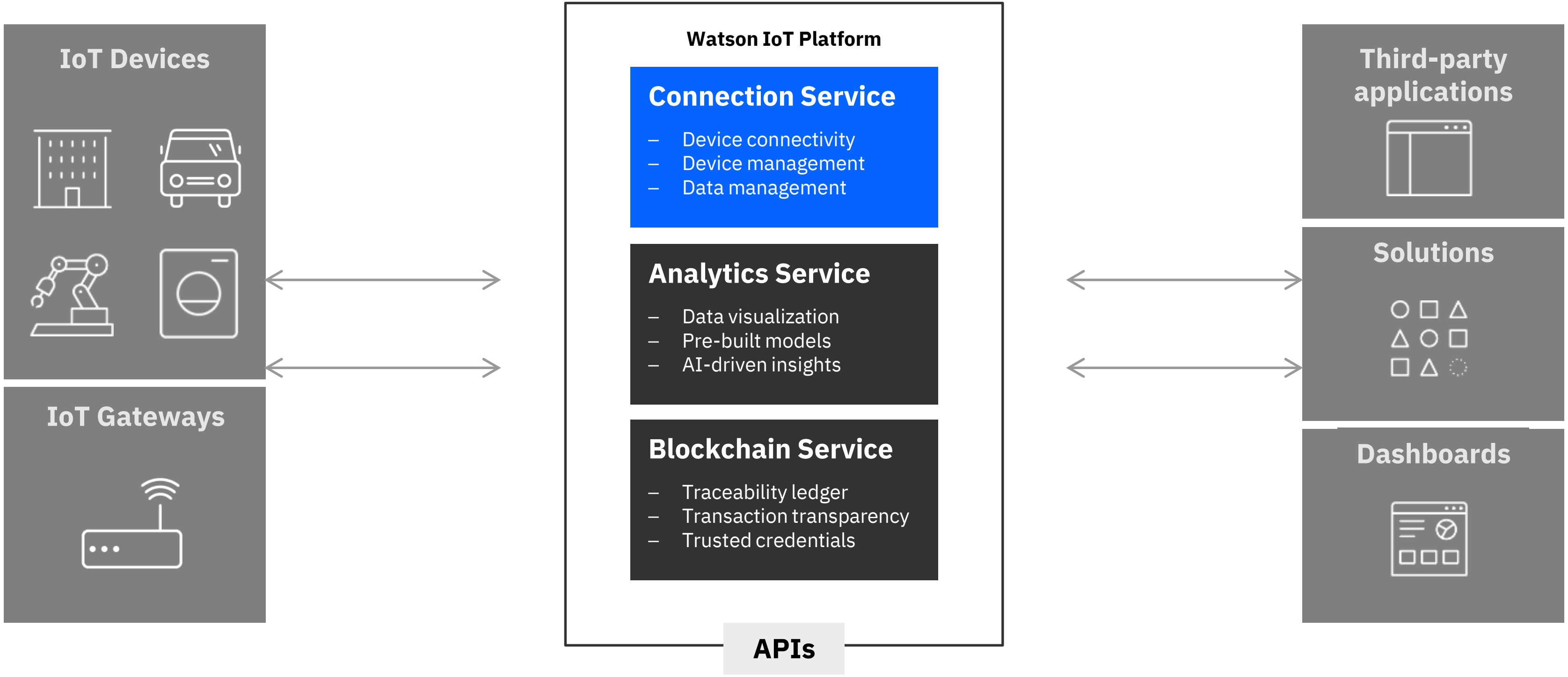


Platform of Platforms

Watson IoT Platform can be integrated with other platforms including 3rd party device and network management platforms and enable system management with specialized services such as AT&T Control Center, Jasper, Orange SIM



IBM Cloud Cognitive Telescopic Network



Internet of Things bring new **Challenges**

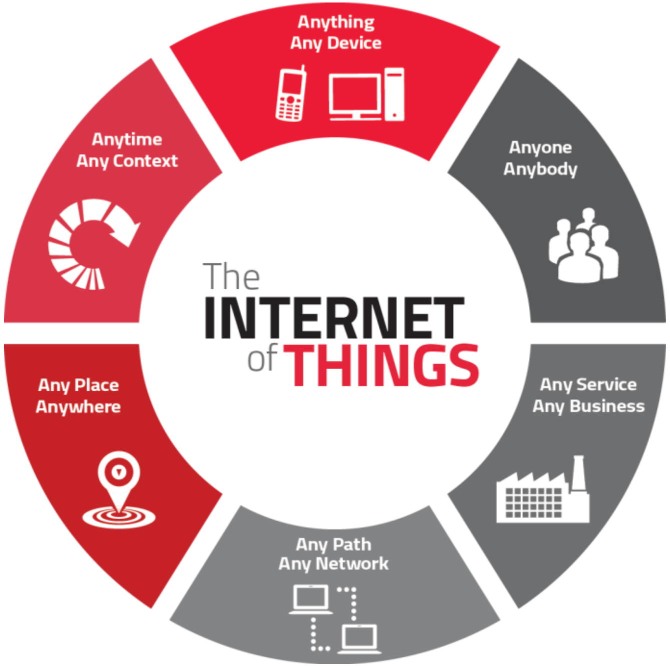
Requires a real time Event Driven model

Publishing information one to many

Listening for events as they happen

Sending small data packets from small devices

Reliably pushing data over unreliable networks



For IoT …. **messaging** (often is) > **HTTP Request/Response**

OASIS

MQTT Version 3.1.1

OASIS Standard

29 October 2014

Specification URIs

This version:

http://docs.oasis-open.org/mqtt/mqtt/v3.1.1/os/mqtt-v3.1.1-os.doc (Authoritative)
http://docs.oasis-open.org/mqtt/mqtt/v3.1.1/os/mqtt-v3.1.1-os.html
http://docs.oasis-open.org/mqtt/mqtt/v3.1.1/os/mqtt-v3.1.1-os.pdf

Previous version:

http://docs.oasis-open.org/mqtt/mqtt/v3.1.1/cos01/mqtt-v3.1.1-cos01.doc (Authoritative)
http://docs.oasis-open.org/mqtt/mqtt/v3.1.1/cos01/mqtt-v3.1.1-cos01.html
http://docs.oasis-open.org/mqtt/mqtt/v3.1.1/cos01/mqtt-v3.1.1-cos01.pdf

Latest version:

http://docs.oasis-open.org/mqtt/mqtt/v3.1.1/mqtt-v3.1.1.doc (Authoritative)
http://docs.oasis-open.org/mqtt/mqtt/v3.1.1/mqtt-v3.1.1.html
http://docs.oasis-open.org/mqtt/mqtt/v3.1.1/mqtt-v3.1.1.pdf

Technical Committee:

OASIS Message Queuing Telemetry Transport (MQTT) TC

Chairs:

Raphael J Cohn (raphael.cohn@stormmq.com), Individual
Richard J Coppen (coppen@uk.ibm.com), IBM

Editors:

Andrew Banks (Andrew_Banks@uk.ibm.com), IBM
Rahul Gupta (rahul.gupta@us.ibm.com), IBM

Related work:

This specification is related to:

- *MQTT and the NIST Cybersecurity Framework Version 1.0*. Edited by Geoff Brown and Louis-Philippe Lamoureux. Latest version: http://docs.oasis-open.org/mqtt/mqtt-nist-cybersecurity/v1.0/mqtt-nist-cybersecurity-v1.0.html.

Abstract:

MQTT is a Client Server publish/subscribe messaging transport protocol. It is light weight, open, simple, and designed so as to be easy to implement. These characteristics make it ideal for use in many situations, including constrained environments such as for communication in Machine to Machine (M2M) and Internet of Things (IoT) contexts where a small code footprint is required and/or network bandwidth is at a premium.

http://docs.oasis-open.org/mqtt/mqtt/v3.1.1/os/mqtt-v3.1.1-os.pdf

MQTT

A lightweight protocol for **IoT messaging**

- Open
- Light weight
- Simple
- reliable

Open specification

Facebook messenger, Billion devices

Minimal overhead

Efficient format

Tiny Clients (Kb)

QoS for reliability on unreliable network

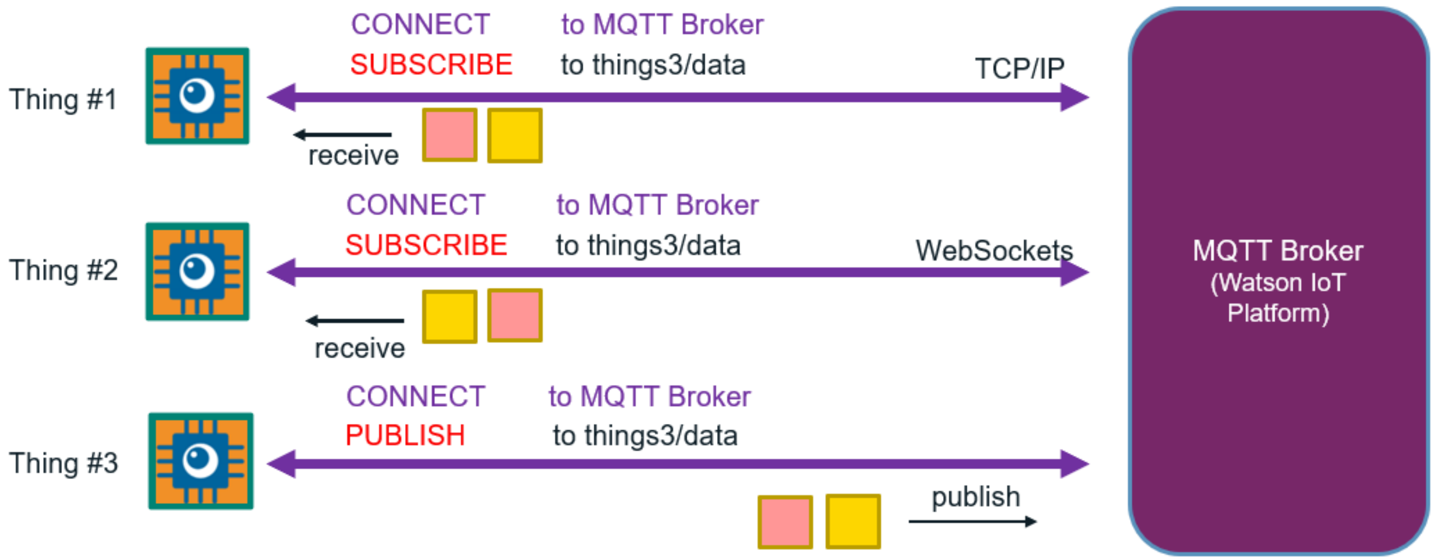
81 pages specification

CONNECT + PUBLISH + SUBSCRIBE + DISCONNECT

ISO 29022

Invented	Published	Eclipse M2M	Standard	Standard
EUROTECH Imagine. Build. Succeed. IBM	MQTT.ORG	paho	OASIS	ISO
Late 1990	August 2010	November 2011	October 2014	June 2016

MQTT bi-directional, async "push" communication



MQTT

simple to implement

Connect

Subscribe

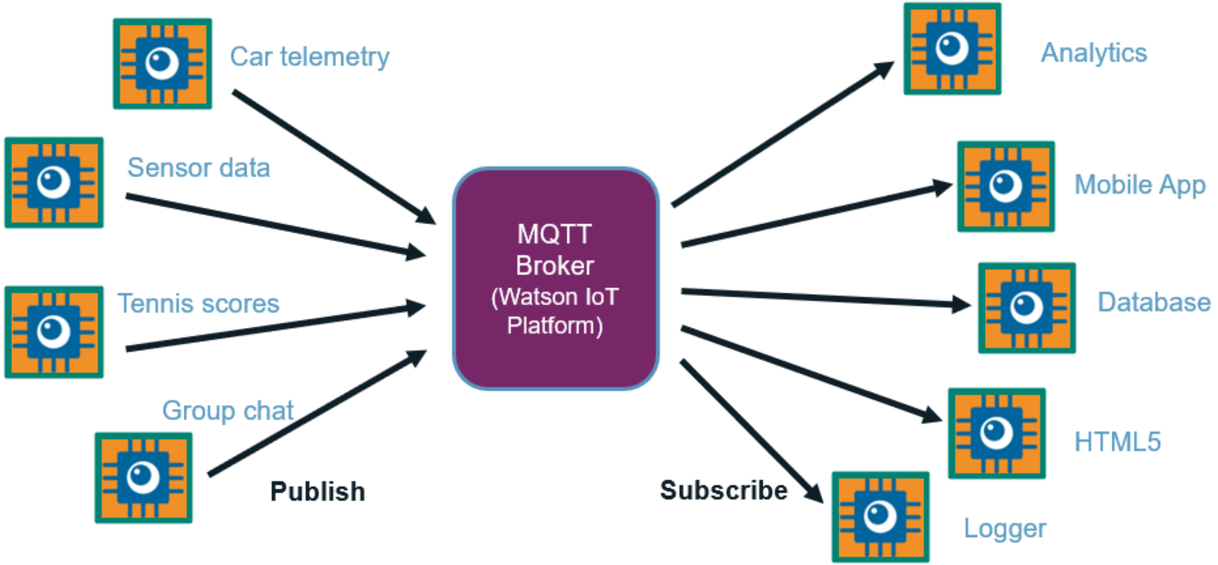
Publish

Unsubscribe

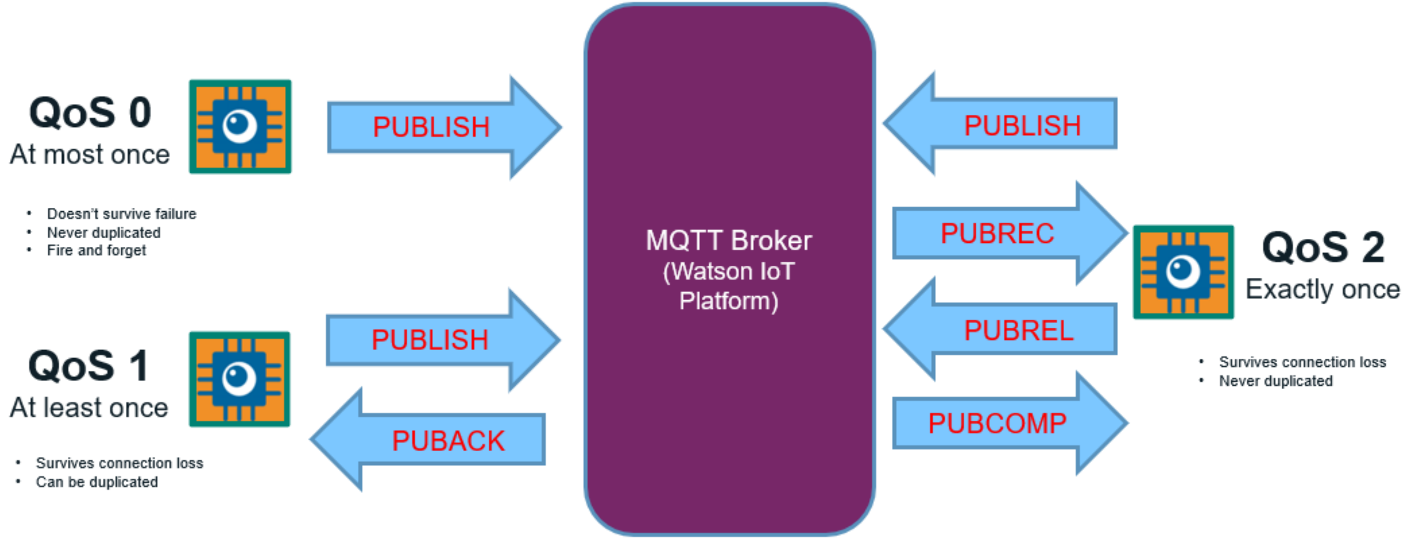
Disconnect

```
client = new Messaging.Client(hostname, port, clientId);
client.onMessageArrived = messageArrived;
client.onConnectionLost = connectionLost;
client.connect({onSuccess: connectionSuccess});

function connectionSuccess() {
   client.subscribe("planet/mars");
   var msg = new Messaging.message("Hello Mars");
   msg.destinationName = "planet/mars";
   client.publish(msg);
}

function messageArrived(msg) {
   console.log(msg.payloadString);
   client.unsubscribe("planet/mars");
   client.disconnect();
}
```

MQTT pub/sub **decouples senders** from **receivers**

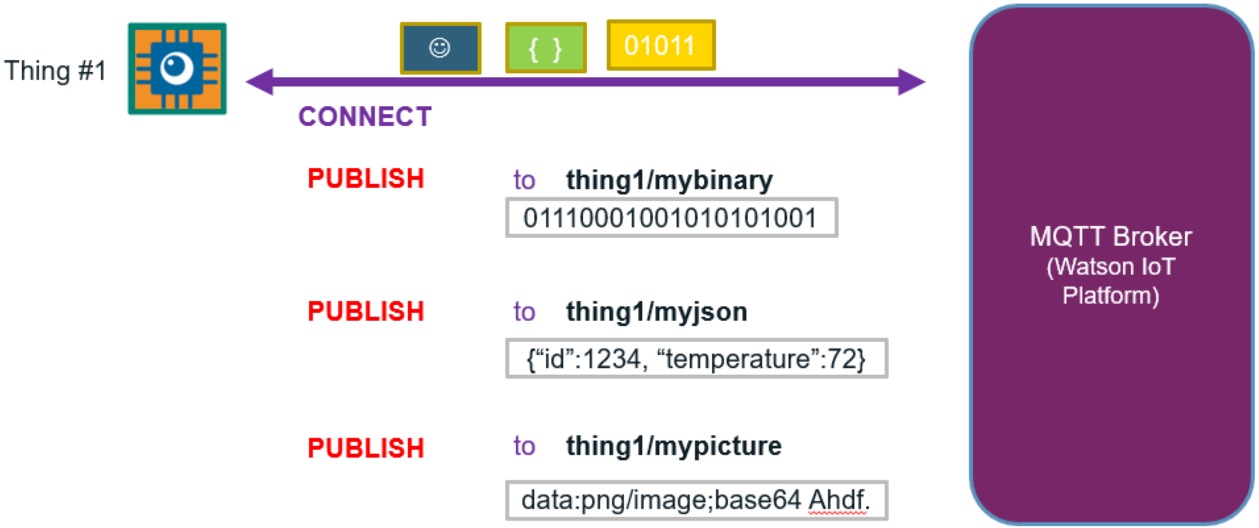


MQTT Quality of Service for reliable messaging

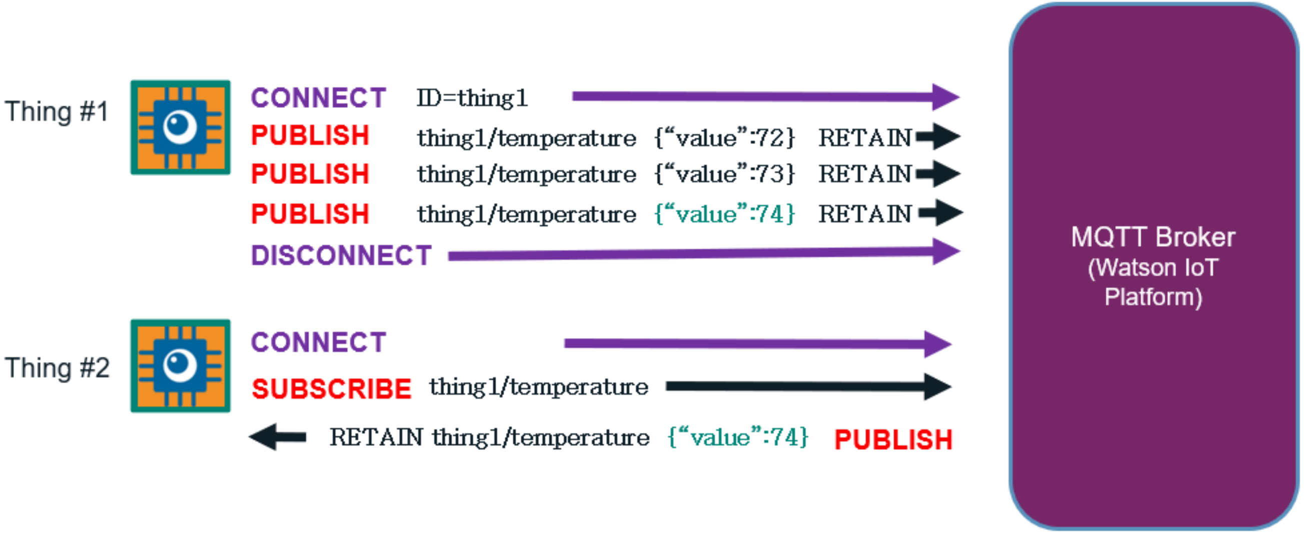


MQTT

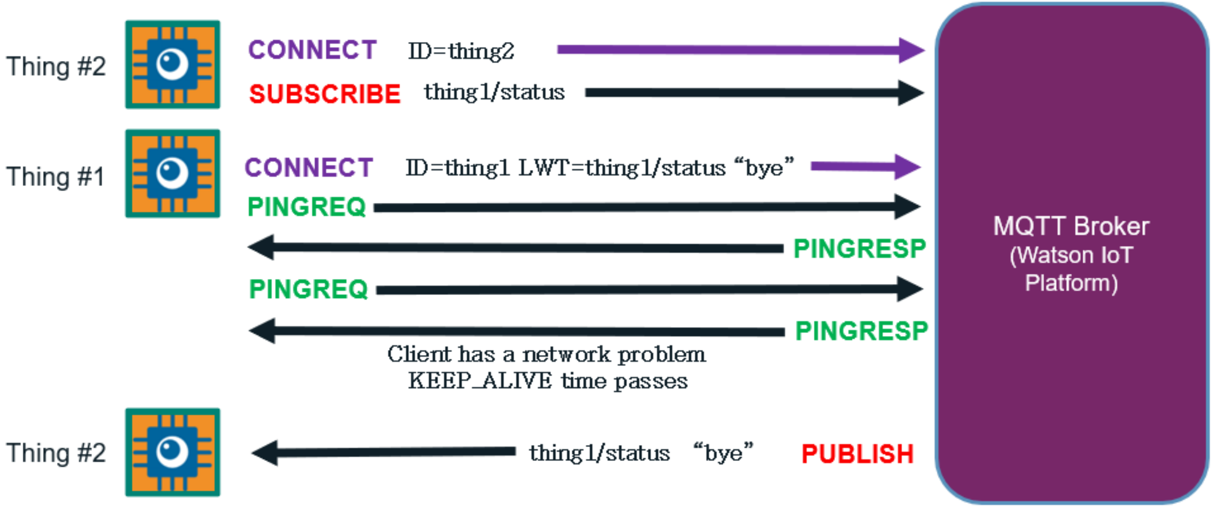
Agnostic payload for **flexible delivery**



MQTT retained messages for last value caching



MQTT last will and testament for presence



The IBM Watson IoT Platform

IBM Watson IoT Platform Connect
Attach, Collect, & Organize, Device Management, Secure Connectivity, Visualization

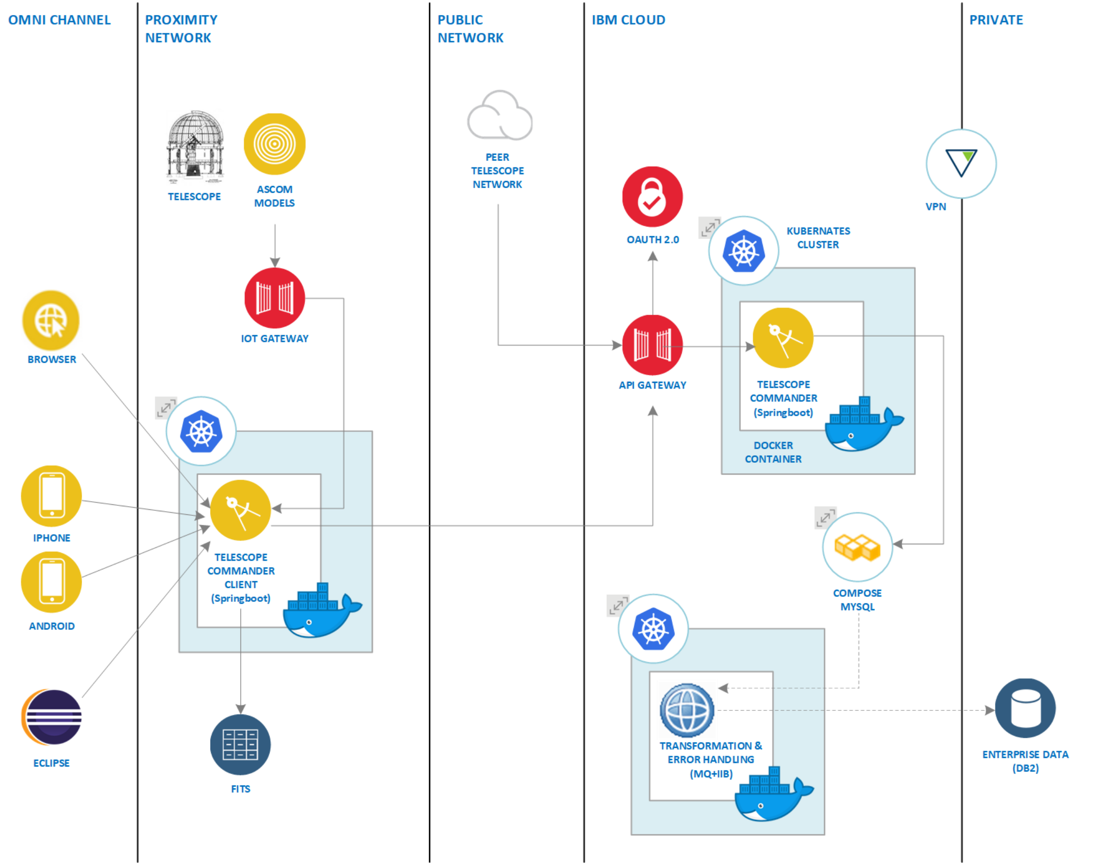
IBM Watson IoT Platform Information Management
Storage & Archive, Metadata Management, Reporting, Streaming data, Parsing and Transformation, Manage unstructured data
Weather APIs

IBM Watson IoT Platform Analytics
Predictive, Cognitive, Real-time, and Contextual

IBM Watson IoT Platform Risk Management
Security Analytics, Data Protection, Auditing/Logging, Firmware Updates, Key/Certificate Management, Org Specific Security.Blockchain (Beta)

IBM Cloud Cognitive Telescopic Network

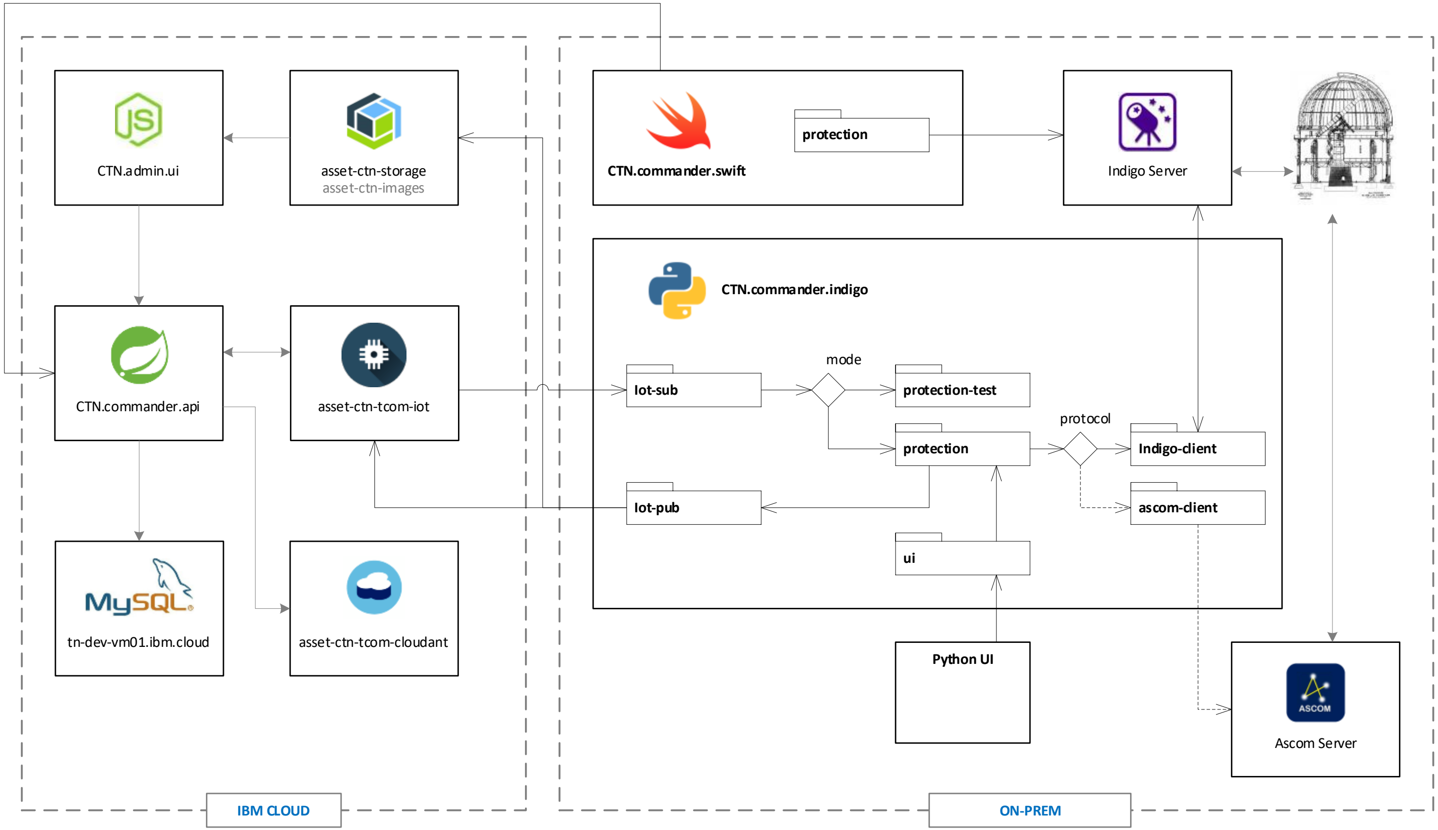
Reference Architecture



- IoT Architecture
  - Based on the Reference Architecture for IoT Reference Architecture

    https://www.ibm.com/devops/method/content/architecture/iot Architecture/0_1

- Omni-channel
  - User Interfaces for Web, Mobile and Eclipse
- Proximity Network
  - Telescope Commander client wraps the ASCOM Objects and provides an API interface
  - Sensors send data using the IoT Gateway
  - FITS data is saved to file system and send to the Server
- Public Network
  - Telescopes can register from other networks using the API for the Telescope Commander
- Bluemix
  - API Implementations using containerized Springboot app
- Yellow Zone
  - Data synchronization with backend Enterprise Database using IIB flows mapping data


CTN.admin.ui
asset-ctn-storage
asset-ctn-images
CTN.commander.swift
protection
Indigo Server
CTN.commander.api
asset-ctn-tcom-iot
CTN.commander.indigo
mode
Iot-sub
protection-test
protocol
protection
Indigo-client
Iot-pub
ascom-client
ui
MySQL
tn-dev-vm01.ibm.cloud
asset-ctn-tcom-cloudant
Python UI
ASCOM
Ascom Server
IBM CLOUD
ON-PREM

IBM Watson Watson Academic Cloud

IBM Cloud

IBM Cloud | Search resources and offerings... | Catalog | Docs | Support | Manage | 1622773 - IBM

Resource list

Create resource

Collapse all | Expand all

Name ▲	Group	Location	Offering	Status	Tags	
Filter by name or IP address...	Filter by group or org...	Filter...	Filter...	Filter...	Filter...	
Devices (8)						
ben-hack.ibm.cloud [redacted]	Classic Infrastructure	Dallas 13	Virtual Server	View status	—	•••
ctn-dev-ascom.asset.ibm.cloud [redacted]	Classic Infrastructure	Dallas 13	Virtual Server	View status	—	•••
ctn-dev-vm01.IBM.cloud [redacted]	Classic Infrastructure	Dallas 13	Virtual Server	View status	—	•••
ctn-dev-vm02.IBM.cloud [redacted]	Classic Infrastructure	Dallas 13	Virtual Server	View status	—	•••
eeh-dev-01.asset.ibm.cloud [redacted]	Classic Infrastructure	Dallas 13	Virtual Server	View status	—	•••
kube-dal13-cr6132eb773b704b02b4856a815... [redacted]	Classic Infrastructure	Dallas 13	Virtual Server	View status	ibm-...	•••
kube-dal13-cr6132eb773b704b02b4856a815... [redacted]	Classic Infrastructure	Dallas 13	Virtual Server	View status	ibm-...	•••
kube-dal13-cr6132eb773b704b02b4856a815... [redacted]	Classic Infrastructure	Dallas 13	Virtual Server	View status	ibm-...	•••
Clusters (8)						
RTP_CAS_team_trial_07242019	RTP-CAS	Dallas	Kubernetes Cluster	Normal	—	•••
asset-ctn	asset-ctn-dev	Dallas	Kubernetes Cluster	Normal	—	•••
big-data	RG-NCSU-BIGDATA	Dallas	Kubernetes Cluster	Normal	—	•••
cluster-elearning-Shadi-Jun20	RG_CAC1_Tam_Test1	Dallas	Kubernetes Cluster	Normal	—	•••
geb-ciigar-analytics	NCSU_CIIGAR_RG	Washington DC	Kubernetes Cluster	Normal	—	•••

FEEDBACK

IBM Watson Watson Academic Cloud

IBM Cloud

Cloud Foundry Apps (3)						
asset-ctn-obdir-eventsub	asset-ctn / ctn-dev	Dallas	Liberty for Java™	Running	—	•••
asset-ctn-tcom-api	asset-ctn / ctn-dev	Dallas	Liberty for Java™	Running	—	•••
java-test-app	asset-ctn / ctn-dev	Dallas		Running	—	•••
Cloud Foundry Services (8)						
asset-ctn-db-db2	asset-ctn / ctn-dev	Dallas	Db2	Updated	—	•••
asset-ctn-obdir-weather	asset-ctn / ctn-dev	Dallas	Weather Company Data	Deletion failure	—	•••
asset-ctn-obdir-weather-data	asset-ctn / ctn-dev	Dallas	Weather Company Data	Deletion failure	—	•••
asset-ctn-obdir-weather-final	asset-ctn / ctn-dev	Dallas	Weather Company Data	Provisioned	—	•••
asset-ctn-social-appconn	asset-ctn / ctn-dev	Dallas	App Connect	Provisioned	—	•••
asset-ctn-streams	asset-ctn / ctn-dev	Dallas	Event Streams	Provisioned	—	•••
asset-ctn-tcom-iot	asset-ctn / ctn-dev	Dallas	Internet of Things Platform	Provisioned	—	•••
availability-monitoring-auto	asset-ctn / ctn-dev	Dallas	Availability Monitoring	Provisioned	—	•••
Services (11)						
Visual Recognition-wn11	asset-ctn-dev	Dallas	Visual Recognition	Provisioned	—	•••
Watson Assistant-z3	asset-ctn-dev	Sydney	Watson Assistant	Provisioned	—	•••

IBM Watson IoT Platform

arunava@us.ibm.com
ID: dbx9ui

Browse | Action | Device Types | Interfaces

Add Device

Search by Device ID

Device Simulator

Device ID	Status	Device Type	Class ID	Date Added	Descriptive Location	Added By	Device Class
2cc825df-b8a0-4b48-a6dc-713226e516da	Disconnected	TelescopeRequest	Device	Oct 10, 2019 7:58 PM	Illinois Institute of Technology	kdillon1@hawk.iit.edu	
2cc825df-b8a0-4b48-a6dc-713226e516da	Disconnected	TelescopeResponse	Device	Oct 10, 2019 8:02 PM	Illinois Institute of Technology	kdillon1@hawk.iit.edu	
234abe31-4d01-32ab-bdac-a96e4490dc78	Disconnected	TelescopeRequest	Device	Oct 12, 2020 3:30 PM	Simulated Telescope 001	a-dbx9ui-ozory9fvl4	
234abe31-4d01-32ab-bdac-a96e4490dc78	Disconnected	TelescopeResponse	Device	Oct 12, 2020 3:30 PM	Simulated Telescope 001	a-dbx9ui-ozory9fvl4	
b5b83b82-c0ab-3924-8147-2ef2d65dab10	Disconnected	TelescopeRequest	Device	Oct 12, 2020 3:30 PM	Simulated Telescope 002	a-dbx9ui-ozory9fvl4	
b5b83b82-c0ab-3924-8147-2ef2d65dab10	Disconnected	TelescopeResponse	Device	Oct 12, 2020 3:30 PM	Simulated Telescope 002	a-dbx9ui-ozory9fvl4	
36e7aa09-fc0a-3156-9718-735b9c29bac9	Disconnected	TelescopeRequest	Device	Oct 12, 2020 3:30 PM	Simulated Telescope 003	a-dbx9ui-ozory9fvl4	
36e7aa09-fc0a-3156-9718-735b9c29bac9	Disconnected	TelescopeResponse	Device	Oct 12, 2020 3:30 PM	Simulated Telescope 003	a-dbx9ui-ozory9fvl4	
785ba2f3-2ef3-35f3-918e-692fafd95a51	Disconnected	TelescopeRequest	Device	Oct 12, 2020 3:31 PM	Simulated Telescope 004	a-dbx9ui-ozory9fvl4	
785ba2f3-2ef3-35f3-918e-692fafd95a51	Disconnected	TelescopeResponse	Device	Oct 12, 2020 3:31 PM	Simulated Telescope 004	a-dbx9ui-ozory9fvl4	
803becef-0698-3278-b708-fda2debf16e9	Disconnected	TelescopeRequest	Device	Jan 27, 2019 3:27 PM	Simulated Telescope 005	a-dbx9ui-ozory9fvl4	
803becef-0698-3278-b708-fda2debf16e9	Disconnected	TelescopeResponse	Device	Jan 27, 2019 3:27 PM	Simulated Telescope 005	a-dbx9ui-ozory9fvl4	
f678fd57-331e-31ae-8f11-2f3be046c09b	Disconnected	CameraRequest	Device	Jan 27, 2019 3:30 PM	Simulated Telescope 001	a-dbx9ui-ozory9fvl4	
f678fd57-331e-31ae-8f11-2f3be046c09b	Disconnected	CameraResponse	Device	Jan 27, 2019 3:30 PM	Simulated Telescope 001	a-dbx9ui-ozory9fvl4	


Thank
You
Vinaka
köszönöm
Kiitos
Maake
Asante
Shukria
Dhanyavadagalu
감사합니다
Dankscheen
спасибо
Kam Sah Hammida
شكرا
Manana
Dankon
Diolch i Chi
Terima Kasih
Matondo
Dank Je
Mauruuru
Biyan
Taiku
Tack
Blagodaram
Ngiyabonga
Dziekuje
Chokrane
Grazie
Juspaxar
Arigato
Mochchakkeram
Gracias
Tingki
நன்றி
Bedankt
Ďakujem
धन्यवाद
cảm ơn bạn
Khap
Paldies
Gratias Tibi
Ua Tsaug Rau Koj
Grazas
Di Ou Mèsi
Kia Ora
Kop Khun
Obrigado
Děkuji
Nirringrazzjak
ありがとう
Suksama
Rahmat
Matur Nuwun
谢谢
хвала
Hvala
Welalin
Djiere Dieuf
Misaotra
Danke
Merci
Go Raibh Maith Agat
Eskerrik Asko
Tuke
Salamat
ขอบคุณ
Najis Tuke

IBM Watson Future of CTN… we are only limited by our imagination

What is the Horsehead Nebula?

Here’s some information about the Horsehead Nebula. Do you want me to see if we can take a picture tonight?

The **Horsehead Nebula** (also known as **Barnard 33**) is a small dark nebula in the constellation Orion. The nebula is located just to the south of Alnitak, the easternmost star of Orion's Belt, and is part of the much larger Orion Molecular Cloud Complex.

Yes

Look up RA DEC:
Right ascension: 05h 40m 59.0s
Declination: −02° 27′ 30.0"

Find available telescopes in the Northern Hemisphere with the correct location and weather conditions.

Only 2 found amongst 10,000 registered telescopes that match the criteria and not tasked.

Calculate the exact exposure, filters, etc. to take the picture for each telescope and camera combination.

Send picture to the CTN user.

- Virtual reality walk-through 3D space and time
- Cognitive pointing technology

https://vimeo.com/243536185

IBM Watson Related collaborations and conference

Deep Learning for Multimessenger Astrophysics: Real-time Discovery at Scale

ILLINOIS
NCSA | National Center for Supercomputing Applications

HOME | AGENDA | TRAVEL/LODGING INFO | PARTICIPANTS | CODE OF CONDUCT

DEEP LEARNING FOR MULTIMESSENGER ASTROPHYSICS: REAL-TIME DISCOVERY AT SCALE

October 17–19, 2018
NCSA Building
1205 W Clark St, Urbana, IL

Scientific Organizing Committee

- Dr. Federica Bianco — New York University; Chair, LSST Transients and Variable Stars Science Collaboration
- Prof. Charles Gammie — Astronomy and Physics, University of Illinois at Urbana-Champaign
- Prof. Bill Gropp — Director, NCSA; Thomas M. Siebel Chair in Computer Science, University of Illinois at Urbana-Champaign
- Prof. Eliu Huerta, *chair* — Gravity Group Lead, NCSA; Department of Astronomy, University of Illinois at Urbana-Champaign
- Dr. Elise Jennings — Data Science Group, Leadership Computing Facility, Argonne National Lab; Associate, Kavli Institute for Cosmological Physics, University of Chicago
- Prof. Daniel S. Katz — Assistant Director for Scientific Software and Applications, NCSA
- Prof. Xin Liu — Department of Astronomy, University of Illinois at Urbana-Champaign
- Dr. Gautham Narayan — Lasker Data Science Fellow, STScI; LSST Dark Energy Science Collaboration and LSST Transients and Variable Stars Science Collaboration
- Dr. Aaron Saxton — Blue Waters Machine Learning Specialist, NCSA
- Prof. Ed Seidel — Physics, Vice President for Economic Development and Innovation, University of Illinois System
- Prof. Zhizhen (Jane) Zhao — Department of Electrical and Computer Engineering, University of Illinois at Urbana-Champaign

Local Organizing Committee

- Prof. Gabrielle Allen — NCSA; Department of Astronomy, University of Illinois at Urbana-Champaign
- Michelle Butler — LSST Lead, NCSA
- Dr. Roland Haas, *chair* — Blue Waters Senior Research Programmer, NCSA
- Prof. Eliu Huerta — Gravity Group Lead, NCSA; Department of Astronomy, University of Illinois at Urbana-Champaign
- Jay Roloff — Associate Director of Project Management, NCSA
- Stacy Walker — Administrative Assistant, NCSA Directors Office

http://www.ncsa.illinois.edu/Conferences/DeepLearningLSST/

HOT-WIRING THE TRANSIENT UNIVERSE
AUGUST 19 - 22, 2019 | NORTHWESTERN UNIVERSITY | EVANSTON, IL | #HOTWIREDVI

HOME | PROGRAM | PARTICIPANTS | TRAVEL & VENUE | LODGING & DINING | REGISTRATION & DEADLINES | CONTACT

PROGRAM

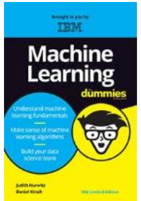
Meeting Rationale

Hot-wiring the Transient Universe VI will explore opportunities and challenges of massively parallel time domain surveys coupled with rapid coordinated multi-wavelength follow-up observations.

The interdisciplinary agenda includes:
(1) Future and ongoing science investigations;
(2) Information infrastructure for publishing observations in real time;
(3) Novel data science to classify events and systems to optimize follow-up campaigns;
(4) Hands on activities to train on alerts from current surveys and broker systems.

https://sites.northwestern.edu/hotwired6/

IBM Watson Further reading and recommendations



Machine learning requires the right set of data that can be applied to a learning process. An organization does not have to have big data to use machine learning techniques; however, big data can help improve the accuracy of machine learning models. With big data, it is now possible to virtualize data so it can be stored in the most efficient and cost effective manner whether on-premises or in the cloud. In addition, improvements in network speed and reliability have removed other physical limitations of being able to manage massive amounts of data at the acceptable speed. Add to this the impact of changes in the price and sophistication of computer memory, and with all these technology transitions, it's now possible to imagine how companies can leverage data in ways that would be been inconceivable only five years ago.

https://www-01.ibm.com/common/ssi/cgi-bin/ssialias?htmlfid=IMM14209USEN

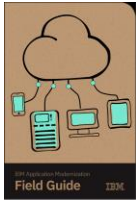
IBM Design Thinking is our approach to applying design thinking at the speed and scale the modern enterprise demands. It's a framework for teaming and action. It helps our teams not only form intent, but deliver outcomes—outcomes that advance the state of the art and improve the lives of the people they serve.

https://www-356.ibm.com/partnerworld/wps/static/watsonbuild/media/IBM%20Design%20Thinking%20Field%20Guide%20Watson%20Build%20v3.5_ac.pdf

The IBM Cloud Garage Method Field Guide documents IBM's approach to enable business, development, and operations to continuously design, deliver, and validate new function. The Garage Method's practices, toolchains and architectures are fundamental to transforming the entire product lifecycle.

- **Practices**
- **Tools and toolchains**
- **Architectures**

https://ibm.biz/garage-method-field-guide



Business pressures demand faster time to market and app modernization. IBM can make this easy for you and bring immediate benefits:

- **Accelerate digital transformation**
- **Improve developer productivity**
- **Improve operational efficiency and standardization**

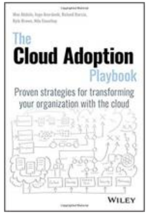
https://www.ibm.com/cloud/garage/content/culture/app-modernization-field-guide/

IBM Watson Further reading and recommendations

IBM Cloud Private offers Platform as a Service (PaaS), with the benefits of a public cloud, including rapid deployment and scalability, increased performance, predictable costs, tighter security and flexible management options. A catalog of certified content provides containerized software, middleware, management and acceleration tools.

- **Security and governance**
- **Speed and elasticity**
- **Built for DevOps**
- **Out of the box accelerators**

https://www.ibm.com/cloud/garage/content/culture/private-cloud-field-guide/



As cloud technologies continue to challenge the fundamental understanding of how businesses work, smart companies are moving quickly to adapt to a changing set of rules. Adopting the cloud requires a clear roadmap backed by use cases, grounded in practical real-world experience, to show the routes to successful adoption. *The Cloud Adoption Playbook* helps business and technology leaders in enterprise organizations sort through the options and make the best choices for accelerating cloud adoption and digital transformation.

https://www.amazon.com/Cloud-Adoption-Playbook-Transforming-Organization/dp/1119491819

The IBM Data and Analytics Strategy Field Guide documents a strategy to connect your business plan and outcomes to your data and analytics requirements. We can help you develop the roadmap to quickly achieve success. It starts with these principles:

- **Make data simple and accessible**
- **Build a trusted analytics foundation**
- **Scale insights on demand**

https://www.ibm.com/cloud/garage/content/culture/data-analytics-field-guide/