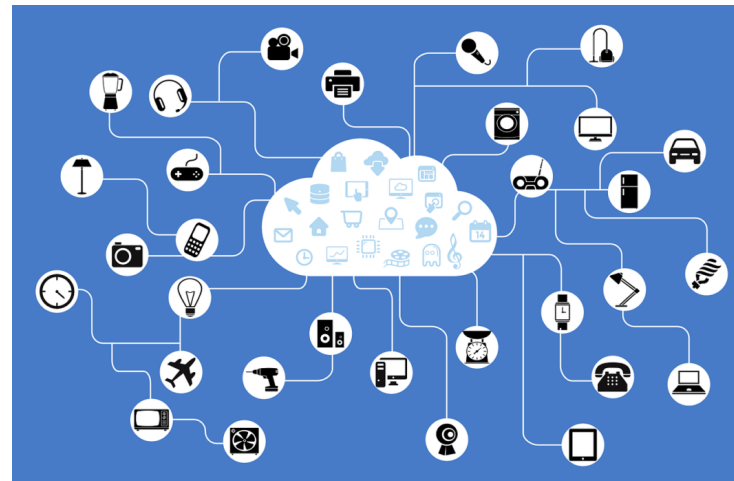




Sirius Microtech LLC  
Innovative People

## Connectivity and Interoperability Of Embedded Systems



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### Little bit about me

- Curious about how things work
- Electronics and Communications Engineer
- Hardware Engineer
- Software, Firmware Architect
- Automation, Machine builder
- Senior Member of IEEE
- Vice Chair of IEEE Computer society, Foothills Section
- Chair of IEEE Consultants Network, Los Angeles
- Founder of Sirius Microtech LLC
- Attitude “Work is for fun”
- Currently working on IoT and LED Lighting applications



### Connectivity

- Ability to meaningful **Communication**
- Information exchange
- Possibility to correct errors
- Repeat reliably



### Why network?

- Connected computers serve content
- Contents consumed by other computers
- Consumption by users
- Place to buy my 'Things'
- Place of learn about 'Things'
- Place to socialize and do fun 'Things'
- Place to download 'Things'
- Market for personal computers – approximately 5!



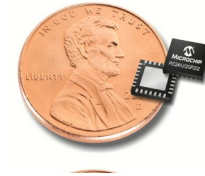
A networked device

- What is this 'Thing'?
- A computing device
- Monitor and Control
- Collect 'Information'
- Work with other 'Things'
- Embedded system



### Embedded system

- Constrained
- Resource strapped
- Headless
- OS, Bare metal
- Battery or Mains powered
- Mostly low power
- Wearable or implantable
- Network connectible





### Network Connection

- Wired
- Wireless
- Between rooms
- Between Buildings
- Across the globe
- Intergalactic
- What is the measure of Connectivity?



### Connectivity

- Well connected
- Some what connected
- Badly connected
- Measure of data availability
- Measure of responsiveness
- Measure of reliability





### How to improve Connectivity?

- Adhere to a known protocol
- Error correction
- Redundancy
- Be specific and smart
- Qualify data



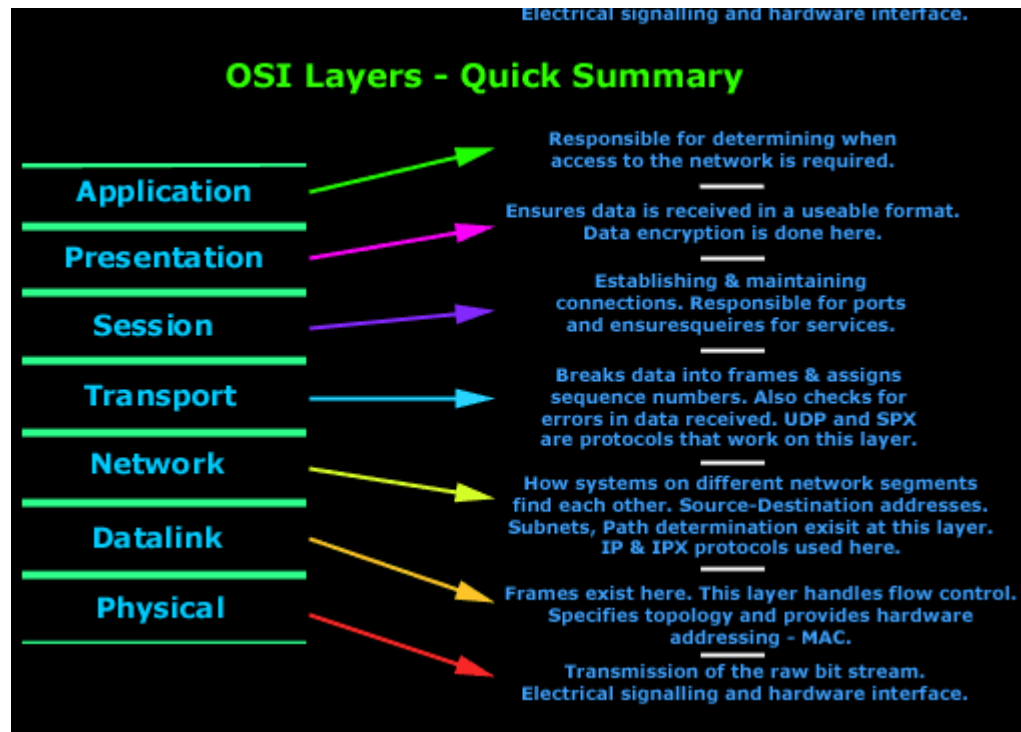
Schiaparelli crashed!

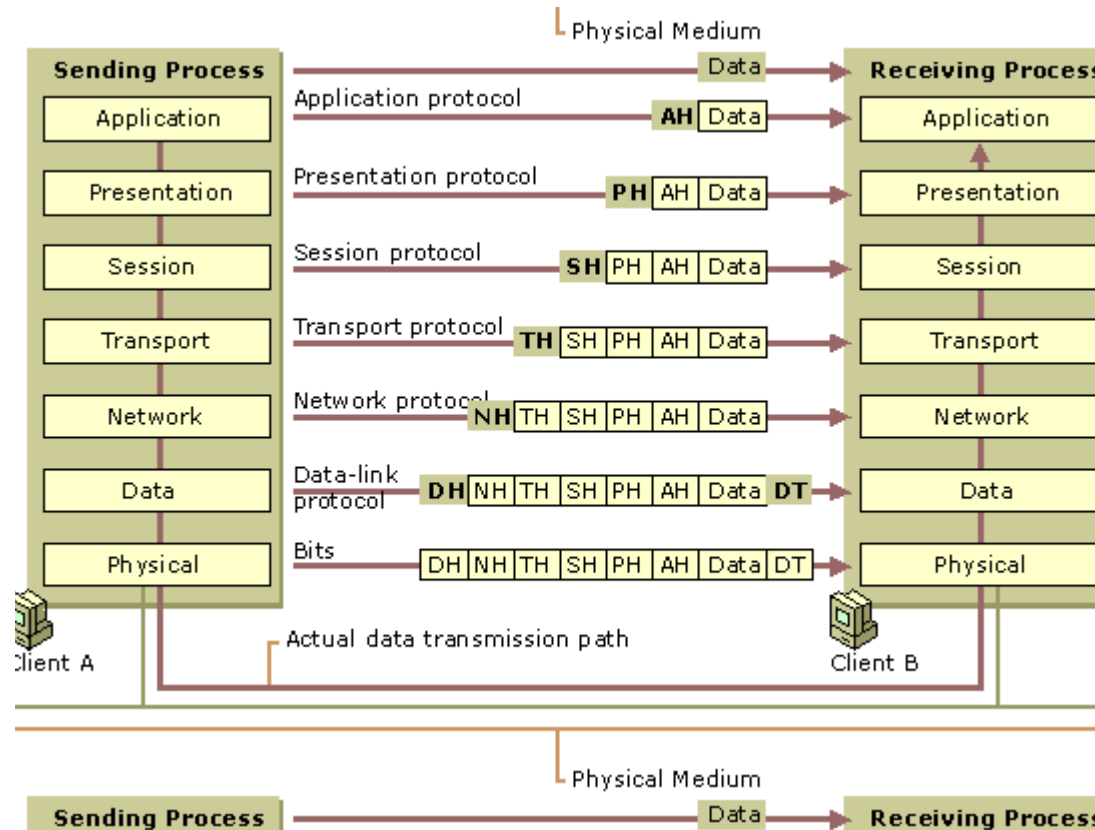
- Inertial measurement system
- Delivered 'bad data'
- Preventable?
- Alleviate
- Standards in Communication
- IEEE Standards for Data Communication



## IEEE Data communications Standards

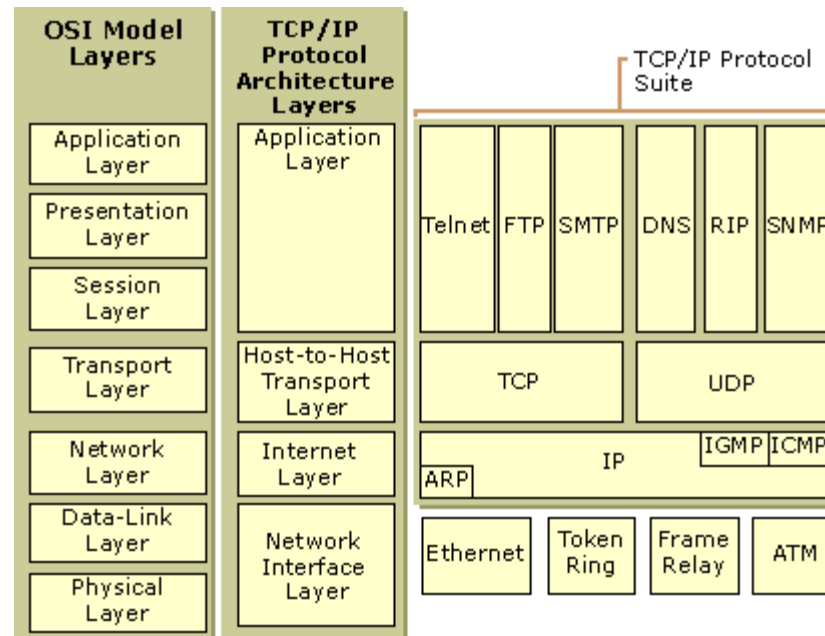
- IEEE 488
- IEEE 802.10 – LAN/WAN
- IEEE 802.11 - WiFi
- IEEE 802.15.2 - Bluetooth
- IEEE 802.15.4 - Zigbee
- IEEE 802.15.6 – Body Area







## Comparison of TCP/IP and OSI models





Standalone Computing  
VS  
Distributed Computing

- How much information is too much in standalone
- Total benefit > sum total of individuals
- Fusion of information
- Bandwidth



### Information flow

- How much can be sent
- How often can we send
- Small data
- Big Data?
- Trillions of Sensors
- Boeing Jet engine – 20TB/hr
- Where to store?
- Smart sensors acting as mini database
- Where to process??





### Making sense of Information

- Do you understand my data
- Tell me what you need to know
- Do you care about what I have?
- Format of data



One way of making sense - Profiles

- Advertise my capability
- I am interested in that capability
- Let's connect
- I will serve data and you consume



Is there an Information standard

- Core.gov
- Internet Engineering Task Force (IETF)
- National Information Exchange Model (NIEM)
- National Institute of Standards and Technology (NIST)
- European Interoperability Framework
- Network Centric Operations Industry Consortium
- Other groups formed by big companies getting together
- Open Platform 3.0, IoTivity,



### Data formats

- Human readable Text
- XML
- Raw Binary
- HTML
- JSON



Are we secure

- Of course not!
- The bright side is - ...
- This the beginning
- We have a wealth of information from IT
- We start safe
- Human error is the most
- Most used password - 12345



### Securing it all

- Encryption
- Validation of Service
- Validation of Connection
- Refuse to service
- Firewall
- Rule based filtering – Blacklist, Whitelist
- IEEE standards for security
- IEEE P1363 – Public-key cryptography
- IEEE P1619 – Storage device encryption
- IEEE P2600 – Security of printers/copiers
- IEEE 802.1AE/X – Media access control security



## Enchanted Objects

### Higher intelligence

Any sufficiently advanced technology is indistinguishable from magic

Convergence into one tool? Divergence into many?

Empowering or make us feel stupid?

How smartphones derailed pervasive/ubiquitous computing...



## Internet Of Things

- What is this?
- Why is it so vague?
- What are we to do with it?
- Why do we care?
- Internet





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Questions!